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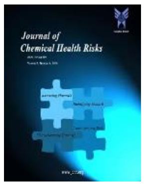

Effect of Organic Sources of Nutrients on Microbial Count of the Soil

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KEYWORDS

Nutrients, Organic sources, Fertilizers, Organic farming

ABSTRACT:

This study investigates how organic sources of nutrients, such as compost and manure, affect the microbial count in soil. Microorganisms play a vital role in maintaining soil health, enhancing plant growth, and cycling nutrients. By adding organic materials, we can increase the diversity and quantity of these beneficial microbes. The findings reveal that organic amendments significantly boost microbial populations compared to conventional fertilizers. This increase leads to improved soil structure and fertility, benefiting agricultural practices. The starting microbial population in the soil was 3x 10^7 cfu/g. Various organic manures exhibited a notable difference in the microbial population of the soil following the harvest. Among the organic manures, the application of FYM (M1) recorded the highest number of microbes (4.40 10^7 cfu/g), followed by the application of vermicompost (M2) with a population of 3.87 10^7 cfu/g, while the lowest microbial count (3.67 107cfu/g) was observed with the application of neem cake (M3). The microbial population after the harvest of the crop found to be non-significant among the sprayings. The interaction effect of varying levels of organic manures combined with sprayings was determined to be non-significant for microbial population. Overall, using organic sources of nutrients not only supports microbial life but also promotes sustainable farming and environmental health.

Introduction

Organic manure lowers cultivation costs while enhancing soil fertility. Additionally, it boosts the soil's capacity to retain water, controls the pH value, and affects the proportion of fossils. Naturally produced food is advantageous for health. The application of chemical fertilizers diminishes the nutrient levels in grains cultivated in the soil by 20 to 25 percent. As a result, plant immunity is compromised. Food cultivated with excessive chemical fertilizers is detrimental to health. This disrupts the balance of naturally occurring mineral elements in the soil. By managing the pH value with organic manure, farmers can achieve improved yields. In the current environment, chemical fertilizers pose health risks and affect well-being. Individuals are succumbing to various diseases. In this context, the government has initiated numerous schemes to encourage organic farming. Consequently, while farmers may gain from increased production, the public will benefit from healthier and cleaner options.

Numerous challenges exist in executing the plan to boost agricultural productivity. One such challenge involves various types of problem soils where production constraints arise from either the soil's physicochemical properties, existing characteristics, or local environmental conditions that hinder crop growth.

Organic sources of nutrients, such as compost, manure, and cover crops, play a significant role in enhancing the microbial count in soil. When these organic materials are added to the soil, they decompose and release nutrients that are not only essential for plant growth but also serve as food for a variety of microorganisms. These microorganisms, including bacteria, fungi, and protozoa, thrive in nutrient-rich environments, leading to an increase in their populations. This increase is beneficial because a higher microbial count can improve soil health by enhancing its structure, aeration, and water retention capabilities. Furthermore, active microorganisms contribute to nutrient cycling, breaking down organic matter and releasing essential nutrients that plants require

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for growth. They also play a role in suppressing soil-borne diseases by outcompeting harmful pathogens. However, the effect of organic nutrients on microbial count can vary depending on factors such as the type of organic matter used and the soil's existing conditions. Regular application of organic amendments encourages a diverse microbial community, promoting resilience and a balanced ecosystem within the soil. Overall, using organic sources of nutrients not only boosts microbial populations but also leads to sustainable agricultural practices and improved soil quality.

Methodology

Soil collection

Soil testing is a crucial aspect of managing soil resources. Every sample taken must be an accurate representation of the area from which it is drawn. The usefulness of the results garnered from laboratory analysis relies on the accuracy of the sampling. Therefore, collecting a large number of samples is recommended to ensure that a sample of the desired size can be achieved through sub-sampling. Typically, sampling is conducted at the rate of one sample per every two hectares of land. Nonetheless, at least one sample should be gathered for a maximum area of five hectares. In soil survey work, samples are gathered from a soil profile that represents the soil of the adjacent area. (Figure 1)

Soil pH before planting and after harvest

The soil pH was measured in soil water suspension (1:10) using glass electrode pH meter.

Microbial count (Microbial count 10° Cfu/g)

For estimating the yeast and mould population in different sample products, dilution plate method was followed. One gram of soil sample was taken and thoroughly mixed in nine milliliter of sterile distilled water. One ml of sample was transferred with a sterile pipette in to a screw cap test tube containing nine ml of sterile distilled water. This gave dilution of 10^{-1}. Similarly serial dilutions were made up to 10^{-10}. One ml of serially diluted sample was placed in the sterile Petri-dish to which 5 ml of potato dextrose agar medium was added and mixed thoroughly the suspension and then allowed to set and then incubated at 30 °C for 48 hrs. Individual colonies were counted and multiplied with the dilution factor to get the microbial population in gram of sample.

$$\text{Cfu/g} = \frac{\text{No. of colonies X sample weight}}{\text{ml plated x dilution factor}}$$

Results

pH

Soil pH value is deemed a crucial element that can influence crop yield. It regulates and manages numerous chemical and biochemical reactions within the soil. It plays a vital role in how plants react to nutrients, with pH also affecting the chemical forms of these nutrients. The pH of the soil significantly influences the populations of micro flora and fauna within it. These pH-related processes greatly affect crop productivity due to available plant nutrients. The data pertaining to the pH of the soil after the experiment as influenced by the organic manures and sprayings are presented in Table 1.

Increased levels of manganese and iron in the soil can make plants susceptible to various diseases. Soil acidity can leach the natural minerals found in the soil. Ions from these metals can be toxic to plants. Acidity also diminishes the availability of several essential nutrients, including phosphorus, calcium, magnesium, and molybdenum. For alkaline soils, mineral solubility is decreased, leading to signs of nutrient deficiency in plants. High pH soils frequently experience deficiencies in iron, manganese, zinc, copper, and boron. Phosphorus is likewise found in a less available form in alkaline soils.

The soil's pH level serves as a measure of its reactivity. If a soil's pH level is 7, then that soil's reaction is considered neutral. If the soil's pH level exceeds 7, then that soil's reaction is alkaline, and if the pH level is even higher. If the pH level is below 7, then that soil's reaction is classified as acidic. Both highly acidic and alkaline reactions in the soil can hinder crop growth. Thus, to achieve optimal crop production, it is necessary to treat such soil to stabilize its pH level.

Microbial count

The data pertaining to the microbial count of the soil after the experiment as influenced by the organic manures and sprayings are presented in Table 2.

Journal of Chemical Health Risks
www.jchr.org
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The initial population of microbes in the soil were 3x 10^7 cfu/g.

Different organic manures showed significant difference on microbial population of the soil after harvest. Among organic manures application of FYM (M) recorded maximum microbes (4.40 x 10^7 cfu/g) followed by application of vermicompost (M_2) with a population of 3.87 x10^7 cfu/g and the minimum microbial count (3.67 10' cfu/g) was recorded with the application of neem cake (M_3).

Among the sprayings microbial population after harvest of the crop found to be non-significant. The interaction effect of different levels of organic manures in combination with sprayings was found to be non-significant for microbial population.

Discussion

Soil acidification is a common natural occurrence in areas with moderate to high precipitation. Agricultural production methods can hasten the soil acidification process through:

– Disturbance of the natural nitrogen (N), phosphorus (P), and sulphur (S) cycles within the soil

– Extraction of agricultural products from the land

– Application of fertilizers and soil amendments that may either acidify the soil or render it more alkaline

Alterations in soil pH can be either beneficial or harmful, depending on the initial pH level of the soil and the rate and direction of the pH change – for instance, reductions in soil pH in alkaline soils might benefit crop production due to improved availability of P and micronutrients like zinc (Zn) (Mitchell et al. 1952).

Conversely, reductions in soil pH for soils that are already highly acidic may have adverse effects by increasing the susceptibility of crops to toxicity caused by the heightened solubility of aluminum (Al) or manganese (Mn) as soil pH decreases (Wright 1989).

Utilization of mineral or organic fertilizers in agriculture enhances the nutrient input to soils, and the manner in which these nutrients are applied along with their fate within the soil-plant system influences the overall impacts on soil pH.

Macronutrients (N, P, potassium (K), and S) predominantly affect soil pH since they are incorporated into the soil in significantly larger amounts compared to micronutrients.

Ammonium-based fertilizers will lower soil pH as they produce two H^+ ions for every ammonium molecule that is nitrified to nitrate. The degree of acidification is contingent upon whether the nitrate derived from ammonium is leached away or absorbed by plants. If plants absorb the nitrate, the net acidification per ammonium molecule is reduced by half compared to when nitrate is leached away. This occurs because one H^+ ion is utilized (or OH^- is released) for each nitrate molecule that is absorbed – this effect is commonly observed as an increase in pH within the rhizosphere. Anhydrous ammonia and urea are less likely to cause acidification than ammonium-based fertilizers due to one H^+ ion being consumed during the conversion to ammonium. Nitrate-based fertilizers have no potential to acidify soil and can actually raise soil pH since one H^+ ion is absorbed by the plant (or OH^- is released) when nitrate is taken up.

When phosphoric acid (PA) is applied to soil, it will invariably acidify the soil as H^+ ions are released – one H^+ ion if the soil pH is below approximately 6. 2 and two H^+ ions if the soil pH exceeds 8. 2.

Monoammonium phosphate (MAP), single superphosphate (SSP) and triple superphosphate (TSP) all contribute P to soil as the $H_2PO_4^-$ ion, which can acidify soil that has a pH greater than 7. 2 but does not influence soil pH in acidic conditions. The P form in diammonium phosphate (DAP) is HPO_4^{2-}, which can acidify soils (pH 7. 2). The hydrolysis of ammonium polyphosphate (APP), wherein the P present as the $P_2O_7^{4-}$ molecule converts to HPO_4^{2-}, is pH neutral, thus any acidification resulting from P addition can be considered similar to DAP. It is sometimes claimed that SSP or TSP can induce soil acidification due to very acidic reaction products;

$$Ca(H_2PO_4)_2 + 2H_2O \rightarrow CaHPO_4 + H^+ + H_2PO_4^{-2}$$

but in soils with pH levels below 7. 7, the following reaction neutralizes the acidity produced, leading to no net acidification;

$$CaHPO_4 + H_2O \rightarrow Ca^{2+} + H_2PO_4^- + OH^-$$

In soils with high pH (pH >7. 2), the release of H^+ ions from the $H_2PO_4^-$ molecule generates some acidity. The

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uptake of P by crops has minimal impact on soil acidity due to the small quantities of fertilizer P absorbed in any given year – therefore, fertilizer chemistry largely dictates pH variations, and notable differences in rhizosphere pH have not been recorded for the uptake of varying orthophosphate ions.

For every molecule of S^0 added to soil, two H^+ ions are produced, and these can be countered through plant uptake by either absorbing H^+ (which is akin to the release of OH^- ions) or generating OH^- (effectively organic anions) within the plant to form alkaline plant material ("ash alkalinity"). If produce is harvested (which is common in agricultural systems), net acidification of soil occurs whe S^0 (nelemental) or ammonium thiosulfate (ATS) are applied. The manner in which potassium is provided to soil – either as muriate of potash (KCl) or sulfate of potash (K_2SO_4) – does not affect soil acidification.

The pH of the soil after the harvest was found to be significant with the application of different levels of organic manures. Among organic manures the minimum pH of the soil available (7.43) in the soil was recorded with the application of vermicompost (M_2) followed by neem cake (M3) with a pH of 7.45 and the maximum pH of the soil (7.46) after harvest was recorded with the application of FYM (M_1). The results are in accordance with Mohammad and David (2016).

Among the sprayings, minimum pH of the soil after the harvest (7.41) was recorded by the application of Arka microbial consortium (F_4) followed by jyeevamruth (F_3) (7.44) and the maximum pH of the soil (7.48) after harvest was recorded with water spray (F_5).

PSB and KMB which were present in the biofertilizer Arka microbial consortium have the ability to solubilize insoluble phosphorus and potassium, respectively. These bacteria secrete organic and inorganic acids such as malic acid, citric acid, formic acid and acetic acid etc. and they lower the pH of soil and bring about the dissolution of bound from nutrients and make them available to plants (Singh et al., 2002).

The interaction effect of different levels of organic manures in combination with sprayings was found to be significant. The minimum pH of the soil (7.33) after the harvest was recorded with the application of vermicompost along with Arka microbial consortium (M_2F_4) followed by the treatment combination neem cake + jeevamruth (M_3F_3) with pH 7.41 and the maximum pH of the soil (7.53) after harvest was recorded with application of FYM + water spray (M_1F_5).

The maximum microbial population in the case of all organic treatments could be attributed to favourable effects of manures in proliferating microbial population by providing carbon as a source of energy for microbes and also protection to enzyme fraction due to increase in the humus content (Martens et al.,1992). The lower bulk density also might have provided good aeration and there by good biological activity (Arun, 2004). The results are in conformity with Nedunchezhiyan et al., 2013.

In addition to enhancing microbial counts, organic nutrient sources also promote beneficial interactions among soil organisms. Many soil microbes engage in symbiotic relationships, where they collaborate to enhance nutrient acquisition for plants. For instance, certain fungi form mycorrhizal associations with plant roots, facilitating improved nutrient uptake, especially phosphorus. These relationships not only help the plants but also create a diverse microbial community in the soil. Organic amendments encourage this diversity by providing a consistent food source that attracts various microorganisms, enabling them to fulfill their ecological roles. As nutrient cycling increases, the overall health of the soil improves, fostering an environment where both microbes and plants can thrive. Additionally, the presence of diverse microbial communities contributes to soil resilience, enabling it to better withstand changes and stressors, such as drought or disease. Research continues to support the notion that organic sources of nutrients are crucial for maintaining high microbial counts that lead to a balanced soil ecosystem. Ultimately, these interactions show how the application of organic matter can be a key strategy in sustainable agriculture, helping to improve soil health, crop productivity, and environmental conservation.

FYM is extensively used organic manure in vegetable cultivation. It improves physical, chemical and biological properties of the soil. It improves the water holding capacity, good aeration and microbial activity in the soil. It also provides buffering action in soil reaction.

Vermicompost is environment friendly and 1s a potential source of readily available nutrients, growth enhancing substances and a number of beneficial micro-organisms

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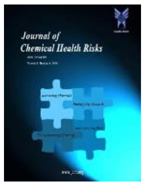

(Hasan et al., 2018). It is helpful in reducing C: N ratio, increases humic acid content and provides most of the macro as well as micro nutrients in the readily available chelated form to the plants such as nitrate exchangeable phosphorus, soluble potassium, calcium and magnesium (Talashilkar et al., 1999).

Organic farming uses a traditional organic fertilizer called Jeevamrutham. The word “Jeeva” means, a living being or any entity imbued with a life force. The word “Amrutham” means elixir of life which is capable of prolonging life i.e., Jeevamrutham is for crop life. Jeevamrutham is the best culture to increase the count of microorganisms. It can be used as a fertilizer for each plant for every week, which boosts the plant growth and gives a good yield.

The combination of microorganisms interact synergistically yields better and show quick results. Many researchers have evidences that development of plant growth promoting microbial consortium could be a feasible technology for increasing the crop productivity with savings in chemical fertilizers to an extent of 25-30 %. Arka microbial consortium developed by IIHR, Bangalore is a carrier-based product which contains N fixing, P & Zn solubilizing and plant growth promoting microbes as a single formulation.

Conclusion

Relatively higher population of soil microflora was recorded in FYM @ 13.6 t/ha and pH (7.43) were lower with the application of vermicompost @ 8.3 t/ha along with Arka microbial consortium @ 7.5 I/ha.

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Table 1. Effect of organic sources of nutrients on pH of the soil

Foliar sprays	**Organic manures**			
	M1: FYM	**M2: Vermicompost**	**M3: Neem cake**	**Mean**
F1: Seaweed extract	7.46	7.46	7.43	7.45
F2: Humic acid	7.44	7.48	7.46	7.46
F3: Jeevamruth	7.45	7.46	7.41	7.44
F4: Arka microbial consortium	7.45	7.33	7.47	7.41
F5: Water spray	7.53	7.42	7.51	7.48
Mean	7.46	7.43	7.45	

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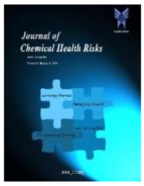

Table 2: Effect of organic sources of nutrients on microbial count (number of colonies × 10^7 cfu/g) of the soil

Factors	SE(m) ±	CD at 5%
Factor (M)	0.01	0.04
Factor (F)	0.02	0.05
Factor (M × F)	0.03	0.08

Table 3: Initial microbial count (number of colonies × 10^7 cfu/g) - 3 x 10^7 cfu

Foliar sprays	Organic manures			
	M1: FYM	M2: Vermicompost	M3: Neem cake	Mean
F1: Seaweed extract	4.33	3.33	3.67	3.78
F2: Humic acid	4	4.33	3.33	3.89
F3: Jeevamruth	5	3.67	4.33	4.33
F4: Arka microbial consortium	4.33	4	3.67	4
F5: Water spray	4.33	4	3.33	3.89
Mean	4.4	3.87	3.67	

Factors	SE(m) ±	CD at 5%
Factor (M)	0.19	0.55
Factor (F)	0.24	NS
Factor (M × F)	0.42	NS

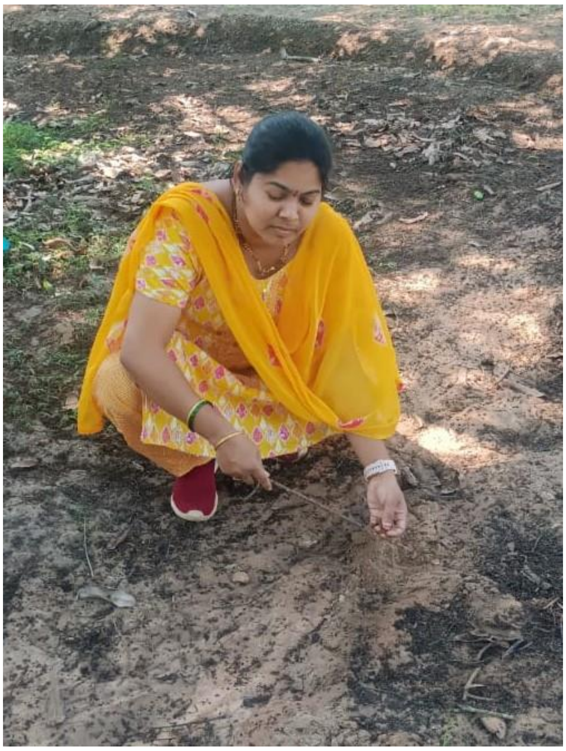

Figure 1: Collection of soil samples from the agricultural fields.