Chapter 1

Introduction

1.1 Background

Soil health is paramount in maintaining the productivity and production quality of farmland soil, as a decrease in soil health may lead to diminished growing capacity and production capability of agricultural land. To mitigate the reduction in soil health caused by improper usage of chemical fertilizers and additives as well as the loss of diversity in the soil ecosystem, the adoption of a more sustainable approach towards agricultural practices would ensure the continued production of high-quality foods but also reduce the negative effects caused by the period of improper management. The environmentally friendly approach to agriculture involves using natural processes and renewable resources to maintain soil health, hence preserving the natural ecosystem and ecological cycles native to the region while boosting the economic stability of farms (Velten et. Al., 2015).

One facet of sustainable agriculture is the use of organic waste in the production of biofertilizer, which utilizes microorganisms or groups of microorganisms that are involved in the conversion of organic matter into bioavailable resources and production of metabolites that enhance plant growth while also offering soil-enhancing benefits such as nitrogen fixation from the atmosphere (Ajijah et. al, 2023). The beneficial organisms involved in the production of biofertilizers are often called Plant Growth Promoting Microbes (PGPM) due to the critical role these microorganisms play in supporting plant growth and health, as according to Kumar and Verma (2018), PGPM has shown the capability to aid plants in tolerating abiotic stresses such as salinity, drought, and heavy metal concentration in soil, while also producing metabolites and hormones that affect the overall state of the plant, the conversion of atmospheric nitrogen into bioavailable forms of nitrogen, and solubilization of minerals found in the soil through acid secretion.

PGPMs are commonly found in composting piles, as the presence of easy-to-break-down organic matter in the compost naturally nurtures the PGPMs that could be found in composting feed such as fruits, leaves, and other organic matter used as feed in the composting process. The process of breaking down organic matter can enrich the nutrient content of the compost while also providing potential benefits to the plant when the compost is applied to the topsoil. Composting is usually defined into two categories, the first being anaerobic composting and the other being aerobic composting.

Anaerobic composting is a composting process that takes place in the presence of no oxygen. Using this method anaerobic microorganisms break down organic matter and develop intermediate compounds such as methane, hydrogen sulfide, organic acids, and other substances, which due to the absence of oxygen, the intermediate compounds do not get metabolized. Most of the compounds emit foul-smelling odors and some are phytotoxic. Anaerobic composting is a low-temperature process, where the microorganism does not emit excess heat during the decomposition process, leaving unwanted weed seeds and pathogens intact. Due to the drawbacks of the process, this method is not often used in agriculture (Misra et al., 2003).

Aerobic composting, on the other hand, takes place in the presence of oxygen. The aerobic microorganism breaks down organic matter into water, carbon dioxide, heat, ammonia, humus, and some intermediate compounds mentioned earlier. The aerobic microorganisms can further decompose the unstable intermediate compounds into more basic compounds, resulting in compost that has little phytotoxicity. The heat generated during the decomposition process further accelerates the breakdown of proteins, fats, and most importantly hemicellulose, while also destroying human pathogens and unwanted weed seeds. The aerobic composting method is the conventional method for compost manufacturing (Misra et al., 2003).

Among the aerobic composting methods, one composting method stood out due to the ease of maintenance, which is the Takakura composting method. The Takakura composting method uses rice, food scraps, and leaves as the primary feed. I3L has been performing research surrounding the usage of Takakura composting for plants, such as the isolation of microorganisms from Takakura compost and the maintenance of isolated microorganisms in a lab environment.

Therefore, the currently proposed research is to explore the Plant Growth Promoting (PGP) capabilities of the PGPMs found in the rhizosphere of the Saga plant (*Abrus precatorius L*) after being planted in compost-treated soil, then isolating the microorganism and perform testing on their nitrogen-fixing and phosphate solubilization capabilities.

1.2 Objective

The objectives of the research are as follows:

1. Determination of morphological characteristics of PGPM from bacterial, fungal and yeast communities in compost-treated soil around the Saga plant (*Abrus precatorius L*) rhizosphere.
2. Determining the capabilities of each microorganism regarding nitrogen-fixing and tricalcium phosphate solubilization.

1.3 Hypothesis

This study tests two hypotheses: The isolates can be identified and categorized into known morphological groups (H0) or not (H1); the isolated samples taken from the compost-treated soil have certain capabilities that aid in the health and growth of plants (H0) or not (H1).

1.4 Scope of Work

The thesis research involves the maintaining of isolates taken from the rhizosphere of the Saga plant, which was grown using Takakura compost mixed soil. The isolates will undergo re-culturing into new media every month to ensure the survival of the microorganism. Fungi, yeast, and bacteria will be incubated at room temperature and observed over 4-6 days to determine microbial growth and viability. This study aims to evaluate the capabilities of the isolates in terms of nitrogen fixation, and phosphate solubilization.