



# Determination of soil nutrient property and *Brassica oleracea* var. *alboglabra* growth in lactic acid bacteria and *Bacillus* spp. fermented soil



FACULTY OF SCIENCE  
CHIANG MAI UNIVERSITY

Pawarisa Sirichum\* and Jomkwan Meerak

Department of Biology, Faculty of science, Chiangmai Mai University

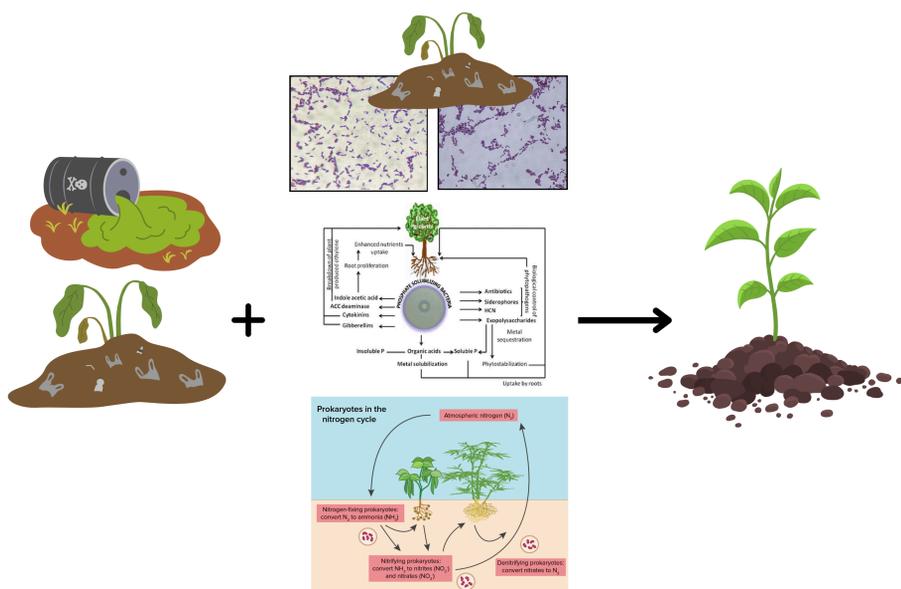
## Abstract

Soil quality is a fundamental factor in agricultural productivity, directly influencing crop growth and yield. However, excessive chemical uses in modern agriculture have led to soil degradation with lower nutrients. Utilization of microorganisms for soil restoration, by degradation of complex organic matters and enhancing solubility of them for effective absorption, is considered as sustainable quality improvement. For this reason, we aimed to evaluate the capability of *Bacillus* spp. and lactic acid bacteria (LAB) that were isolated from agricultural soils in Chiang Mai to improve the quality of degraded soils and preliminary effect on the growth of *Brassica alboglabra* or Chinese kale. Seven bacterial isolates, including *Bacillus subtilis* C5, *Limosilactobacillus fermentum* V3, *Bacillus proteolyticus* ET11, *Bacillus cabrialesi* P5, *Calidifontibacillus enzukumensis* P12, *Bacillus tequilensis* P14 and *Lactiplantibacillus argentoratensis* A11, were individually mixed with degraded soils while MARS liquid medium and 0.85% NaCl were used as the control. Total amount of nitrate ions, solubilized phosphorus, potassium, electrolytes, pH, soil texture and total organic matters in fermented soil were examined. By preliminary screening of those isolates based on their ability to produce enzymes and phosphate solubilization on solid medium, *Bacillus* spp. (high production of cellulase and P solubilizing) mixed soils showed the better values of nitrate, solubilized phosphorus, and total organic matters than LAB mixed soils and control at 45 days of fermentation. In addition, three formulae of those bacteria, were combined for initial development and assessed for stimulation of Chinese kale for early and late growth at 15 and 30 days. Fermented soil with *Bacillus* mixed with lactic acid bacteria were able to stimulate overall growth of shoot, root, and stem better than control (water mixed soil) at least 3 times at 15 days but no significant of shoot and stem lengths were different at 30 days. However, the formula that combined soils with LAB only, especially V3, was not able to promote plant growth and seemed to reduce the pH of soil to be more acid (pH 6 to 3) which the kale could not tolerate during the first 5 days. However, this research was focused on the possibility of utilizing those bacteria to improve the quality of soil and these preliminary findings will be deeply examined and developed for specific applications. Formulation of bacterial biofertilizer or soil amendment may need further selection from several characteristics of bacteria.

## Introduction

Soil fertility is a key factor influencing plant growth and agricultural productivity. Essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K) play a vital role in supporting plant development. However, excessive use of chemical inputs in agriculture has led to soil degradation and reduced fertility. Therefore, sustainable strategies are needed to restore soil health and enhance crop yields.

Lactic acid bacteria (LAB) and *Bacillus* spp. contribute to soil nutrient enrichment and plant growth promotion. LAB produces organic acids that help solubilize phosphorus and other nutrients, improving plant absorption. Meanwhile, *Bacillus* spp. can fix nitrogen and produce plant growth hormones like indole-3-acetic acid (IAA), along with disease control properties.

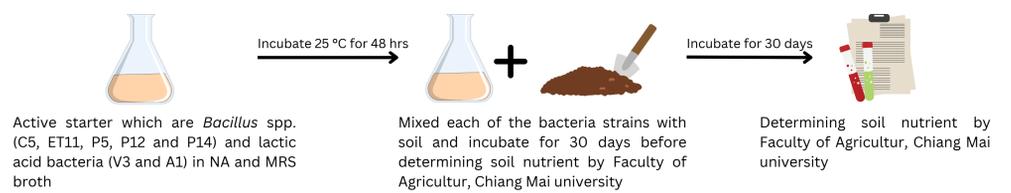


## Acknowledgement

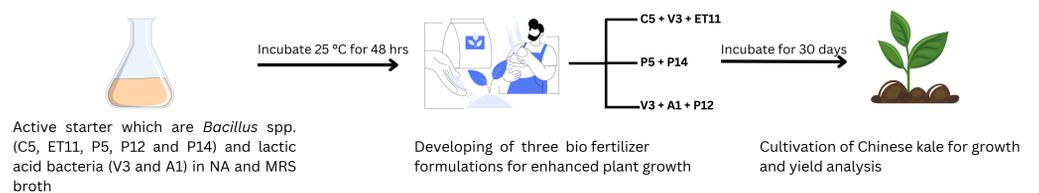
SCB 2813 Laboratory Microbiology, Department of Biology, Faculty of science, Chiang Mai university

## Methodology

### Determination of soil nutrients



### Evaluation of Plant Growth-Promoting Potential of *Bacillus* spp. and lactic acid bacteria



## Results and Discussion

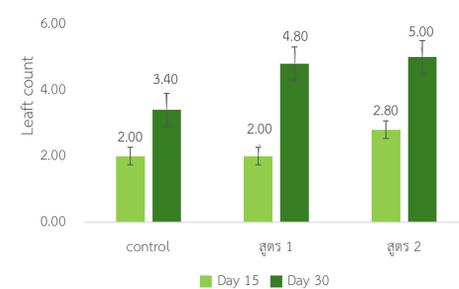


Figure 1 number of leaves of *Brassica alboglabra* grown in 3 soil bio fertilizer formulations

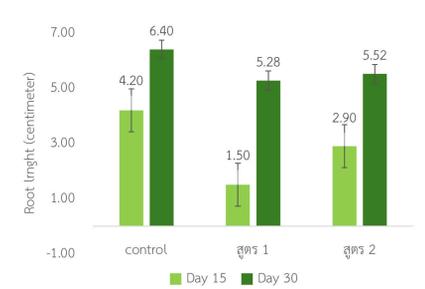


Figure 2 root length of *Brassica alboglabra* grown in 3 soil bio fertilizer formulations

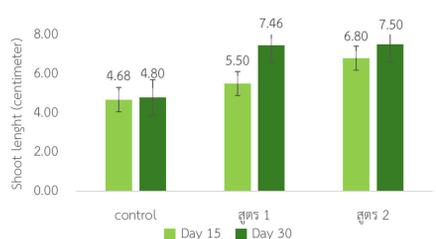


Figure 3 shoot length of *Brassica alboglabra* grown in 3 soil bio fertilizer formulations

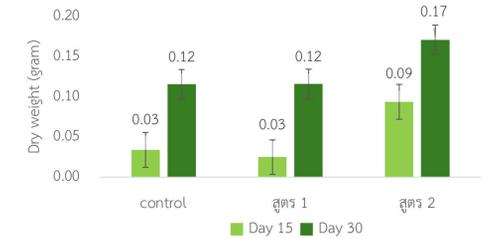


Figure 4 dry weight of *Brassica alboglabra* grown in 3 soil bio fertilizer formulations

The bacterial strains were applied to the soil in two parts. Part 1 involved soil analysis after a 30 day incubation, measuring nitrate, phosphorus, potassium, pH, soil texture, and organic matter content. Part 2 involved formulating three biofertilizer treatments: (1) a mixture of V3, C5, and ET11 (150 mL); (2) a mixture of P5 and P14 (150 mL); and (3) a mixture of V3 (50 mL), A1 (200 mL), and P12 (150 mL). These formulations were tested on *B. alboglabra*, with plant growth parameters - leaf number, shoot length, root length, and dry weight measured on days 15 and 30. The results showed that biofertilizer formulation 2 significantly increased leaf number, root length, and dry weight at  $p < 0.01$  on day 15. Shoot length was significantly higher in plants treated with formulations 1 and 2, with no significant difference between the two. By day 30, formulations 1 and 2 significantly improved leaf number and shoot length compared to the control ( $p < 0.01$  and  $p < 0.05$ , respectively). However, there were no significant differences in root length and dry weight among the treatments and the control.

## Conclusion

Results showed that biofertilizer formulation 2 (*Bacillus cabrialesi* P5 and *Bacillus tequilensis* P14) was the most effective, significantly increasing leaf number, shoot length, and dry weight. This effect may be attributed to enhanced nutrient uptake or the production of plant growth-promoting substances.

## References

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