NSIEX+RS 2025
NEGERI SEMBILAN INTERNATIONAL EXPOSITION

HARMONY IN PROGRESS:

INTEGRATING SCIENCE, TECHNOLOGY, AND SOCIAL INNOVATION FOR SUSTAINABLE DEVELOPMENT GOALS

e-Book of Extended Abstract
Negeri Sembilan International (NSIEx) & Research Symposium
2025

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NEGERI SEMBILAN INTERNATIONAL EXPOSITION

PST006 - Z-FERT: NATURAL FERTILITY FOR BETTER PLANT GROWTH

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ABSTRACT

Global agriculture faces critical challenges as soil fertility declines due to intensive farming practices and excessive chemical fertilizer use, with approximately 33% of soils worldwide being moderately to highly degraded. This study introduces Z-FERT, an innovative biological approach that utilizes *Zophobas atratus* larvae to transform horse dung into an effective organic fertilizer for enhanced plant growth. The research employed a Randomized Complete Block Design with seven replicates per treatment, conducted over six weeks using *Spinacia oleracea* (spinach) as the model plant species. The experimental framework incorporated *Z. atratus* larvae (1.5-2.5 inches) to accelerate the decomposition of sterilized horse dung (100g per sample), creating a nutrient-rich organic fertilizer. Soil organic matter content, plant height, dry biomass, and relative growth rate were measured using Loss on Ignition method and statistical analysis through two-way ANOVA and paired t-tests. Results demonstrated that horse dung-treated soil showed significantly higher organic matter content (2.588 ± 0.13%) compared to control groups. Plants grown in horse dung-treated soil exhibited significantly greater height increases ($p = 0.001$), with growth rates of 19.05% versus 14.29% in control conditions. The relative growth rate was also significantly higher (0.025±0.004 g/day) compared to control soil (0.012±0.0026 g/day). This innovative approach represents a breakthrough in sustainable agriculture by providing a scientifically rigorous, economically viable solution to soil degradation. Z-FERT harnesses natural decomposition processes to create a scalable alternative to chemical fertilizers while reducing organic waste pollution and CO_2 emissions, ultimately supporting next-generation farming practices that balance high productivity with environmental stewardship.

Keywords – organic fertilizer, plant growth, soil fertility, sustainable agriculture, Zophobas atratus

INTRODUCTION

Global agriculture is facing a major challenge as soil fertility declines due to intensive farming and excessive chemical fertilizer use. Around 33% of soils worldwide are moderately to highly degraded (FAO & IPTS, 2020), reducing productivity and ecosystem services. In tropical regions like Southeast Asia, continuous chemical use causes erosion,

nutrient imbalance, and loss of organic matter (Montanarella et al., 2016). This harms soil health, pollutes the environment, and raises farming costs.

Natural fertilizers are gaining increasing attention as sustainable alternatives to chemical inputs in agriculture. Among these, compost derived from animal manure provides essential nutrients while improving soil health and structure. Horse dung, in particular, is rich in organic matter and beneficial microorganisms and has the ability to heat up the compost pile, making it a valuable resource for composting. It provides essential macro and micronutrients for plant growth. Composted horse manure can improve soil fertility, structure, and water retention.

Recent research has explored the use of insect larvae, such as *Z. atratus* (commonly known as superworm), to accelerate the composting process and enhance the nutrient profile of the resulting fertilizer. These larvae efficiently break down organic waste and some plastics, contributing to a more rapid and eco-friendly composting method, converting various waste materials into biomass and frass.

This study investigates the potential of composted horse dung processed by *Z. atratus* larvae as a natural fertilizer for spinach (*S. oleracea*) cultivation. Spinach was chosen as a fast-growing leafy vegetable that is highly responsive to soil fertility and nutrient availability. Utilizing insect-assisted composting offers a sustainable method for organic waste management, a low-cost alternative to restore soil fertility, reduce reliance on chemical fertilizers, and enhance crop productivity. The findings could provide valuable insights into integrated organic farming systems and circular agriculture practices.

OBJECTIVE

To assess the effectiveness of horse dung as an organic fertilizer for *Spinacia oleracea*, facilitated by the decomposition capabilities of *Zophobas atratus* larvae.

DESCRIPTION OF THE PROJECT

The research employs a comprehensive experimental design using a Randomized Complete Block Design (RCBD) with seven replicates per treatment, conducted at UiTM Negeri Sembilan Kampus Kuala Pilah under controlled conditions. The key experimental components include *Z. atratus* larvae (1.5-2.5 inches), sterilized horse dung (100g per sample) as substrate types, *S. oleracea* (spinach) as the model plant for growth assessment, and a 6-week monitoring period. The measurement parameters encompass soil organic matter content using the Loss on Ignition (LOI) method, plant growth metrics including height, dry biomass, and relative growth rate, with statistical analysis using two-way ANOVA and paired t-tests.

Soil organic matter (SOM) content in horse dung-treated soil vs. Control

Horse dung-treated soil ($2.588 \pm 0.13\%$) showed higher organic matter content than the control, indicating its potential to enhance soil fertility and support plant growth. The presence of *Z. atratus* larvae further accelerated dung decomposition, improving soil quality through increased organic matter and nutrient content (Khalil et al., 2020).

Mean weekly plant height increase based on dung treatment

The effect of horse dung, as a source of organic matter, on the increase in *S. oleracea* height was identified, and indirectly, the planting duration was also compared to determine its impact on the growth of the species (Figure 1).

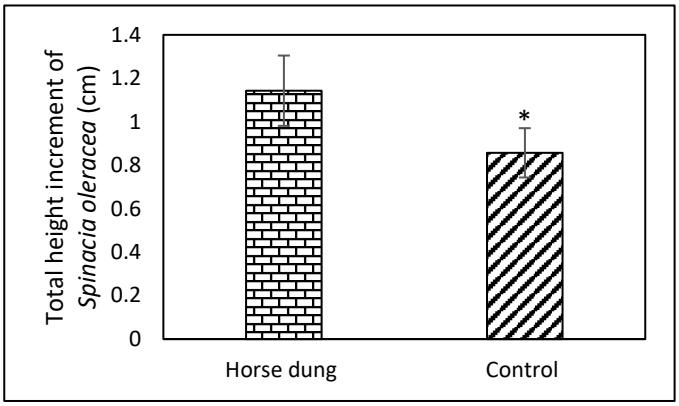

Figure 1: Total height increase of Spinacia oleracea in horse dung-treated soil and control soil.

Based on the analysis, there was no significant interaction between dung and week, $F_{(4, 60)} = 0.63$, $p = 0.642$, suggesting that the influence of dung type on plant height was consistent across the planting weeks. A significant main effect of dung was found, $F_{(1, 60)} = 12.63$, $p = 0.001$, indicating that *S. oleracea* fertilized with horse dung had significantly higher plant height than the control. These findings are also supported by Table 1. Similarly, the planting period (week) had a significant main effect, $F_{(4, 60)} = 6.63$, $p = 0.001$, where longer planting durations resulted in significantly greater plant height compared to shorter periods.

Table 1: Growth rate (%) and relative growth rate (g/day) of treated and untreated Spinacia oleracea

Parameter	Horse Dung Treatment	Control	p-value	Significance ($p < 0.05$)
Growth Rate (GR) (%)	19.05%	14.29%	0.003	Significant
Relative Growth Rate (RGR) (g/day)	0.025±0.004	0.012±0.0026	0.001	Significant

Biomass, the total dry matter produced, reflects plant growth and vitality. Its increase is linked to higher organic matter and key nutrients (N, P, K) in horse manure, which improve soil structure, boost microbial activity, and enhance nutrient uptake. Plants that grow in soil with high organic matter content tend to show improved growth, such as height. The improvement is believed to be associated with the enhancement of fertility by *Z. atratus* larvae, especially regarding nutrient cycling in the soil (Bottinelli et al., 2021). This result indicates a highly significant positive effect of horse dung on plant growth performance under experimental conditions. These findings are supported by Kovács et al. (2016), who demonstrated that horse manure boosts spinach shoot and root biomass by enhancing soil N and P levels.

NOVELTY

This study introduces an innovative biological approach using *Z. atratus* larvae to enhance soil fertility through organic waste processing. While previous research has explored various decomposer organisms (Zhang et al., 2023), limited studies have specifically investigated the synergistic effects of *Z. atratus* larvae on horse dung on soil fertility and plant growth. This innovation lies in the use of *Z. atratus* larvae as living bioreactors for the decomposition of organic waste, specifically horse dung. When the waste is processed by the larvae, a controlled experimental framework is established to measure improvements in soil fertility and plant growth responses, ultimately providing a scalable and sustainable alternative to chemical fertilizers. Economically, it enhances plant growth, increases agricultural yields and productivity, while transforming waste into valuable resources. From a sustainability perspective, this reduces organic waste and odour pollution and lowers CO_2 emissions from manure, helping to mitigate climate change.

CONCLUSION

The proposed study transforming horse dung into an organic fertilizer using *Z. atratus* larvae represents a breakthrough in sustainable agriculture. It confirms the suitability of traditional cow and goat manure and expands the toolkit to include horse dung. This research delivers a scientifically rigorous, economically viable solution to soil degradation by harnessing the larvae's natural decomposition abilities. It paves the way for next-generation farming practices that balance high productivity with environmental stewardship.

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