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Influence of drip fertigation using vermitea on Chinese cabbage (*Brassica rapa* L. var. *pekinensis*) in low-nutrient area

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ABSTRACT

The study was conducted to evaluate the effect of drip fertigation using different concentrations of vermitea on the growth and yield performance of Chinese cabbage (*Brassica rapa* L. var. *pekinensis*) under low nutrient field conditions. The experiment was carried out from December 2024 to February 2025 at the experimental area of Mindanao State University–Sultan Naga Dimaporo using a Randomized Complete Block Design (RCBD) with seven treatments and three replications. The treatments consisted of varying amounts of vermicast mixed in 8 liters of water, namely: control, 130 g, 430 g, 730 g, 940 g, 1,150 g, and 1,360 g. Vermitea was applied through a drip fertigation system at seven-day intervals. Growth and yield parameters measured included number of leaves, leaf diameter, plant height, plant diameter, plant weight, number of heads per plot, weight of marketable plants, weight of non-marketable plants, and yield expressed in tons per hectare. Results showed that the different vermitea concentrations did not significantly affect any of the measured parameters. Although some treatments produced slightly higher numerical values, statistical analysis revealed no significant differences among treatments at the 5% level of significance. The findings suggest that the vermitea concentrations used in the study did not significantly improve the growth and yield performance of Chinese cabbage under the prevailing environmental and low nutrient conditions. Further studies using higher nutrient concentrations and improved environmental management are recommended to better assess the potential of vermitea applied through drip fertigation in vegetable production.

Key words: Drip fertigation, Vermitea, Chinese cabbage, Vermicast concentration

INTRODUCTION

Agricultural production is increasingly challenged by declining soil fertility, climate variability, and the excessive use of chemical fertilizers. In many farming areas, continuous cultivation and improper nutrient management have contributed to soil degradation and reduced crop productivity. These concerns have encouraged the adoption of more sustainable agricultural practices that can maintain crop production while minimizing environmental damage. Conservation-based approaches that promote efficient nutrient use and organic inputs are now widely recognized as important strategies for improving soil health and supporting long-term agricultural sustainability (Kassam *et al.*, 2019; Pretty *et al.*, 2018).

Chinese cabbage (*Brassica rapa* L. var. *pekinensis*), commonly known as Napa cabbage or pechay Baguio, is one of the most widely consumed leafy vegetables in many Asian countries. It is valued for its nutritional content, particularly its fiber, vitamins, calcium, and antioxidant compounds that contribute to human health (Seong *et al.*, 2016; Okamoto *et al.*, 2021). Due to its relatively short growing period and high market demand, Chinese cabbage has become an important vegetable crop among small-scale farmers. However, its productivity is highly dependent on adequate nutrient supply and favorable environmental conditions. In low nutrient soils, crop growth and yield are often limited because plants are unable to obtain sufficient nutrients necessary for proper development (Prasad *et al.*, 2024).

Traditional fertilizer application methods are commonly associated with nutrient losses, uneven nutrient distribution, and inefficient uptake by plants. Excessive fertilizer use may also contribute to soil deterioration, nutrient imbalance, and environmental pollution (Qi *et al.*, 2022). In response to these concerns, drip fertigation has gained attention as an efficient method of supplying water and nutrients directly to the root zone of crops. This method improves nutrient use efficiency while reducing water loss and fertilizer wastage (Anusree *et al.*, 2020). Drip fertigation is particularly useful in vegetable production where consistent moisture and nutrient availability are essential for optimum growth.

At the same time, organic nutrient sources such as vermitea are increasingly being explored as alternatives to synthetic fertilizers. Vermitea is a liquid extract derived from vermicast and contains dissolved nutrients, beneficial microorganisms, and bioactive compounds that may enhance plant growth and soil biological activity (Aslam *et al.*, 2023). Previous studies have reported positive effects of vermitea on the growth and productivity of several vegetable crops. However, information regarding its effectiveness when applied through drip fertigation under low nutrient field conditions remains limited, particularly in Chinese cabbage production.

Considering these conditions, the study was conducted to evaluate the effect of different vermitea concentrations applied through drip fertigation on the growth and yield performance of Chinese cabbage. Specifically, the study aimed to determine whether varying levels of vermicast extract could improve plant growth, head development, and yield under low nutrient conditions. The findings of the study may provide useful information for farmers, students, and future researchers interested in sustainable vegetable production and the practical use of organic fertigation systems.

MATERIALS AND METHODS

Study area

The study was conducted at the experimental area of Mindanao State University–Sultan Naga Dimaporo located in Ramain, Sultan Naga Dimaporo, Lanao del Norte, Philippines. The area is situated in the southwestern part of the province and is generally characterized by a warm lowland climate suitable for vegetable production. The experiment was carried out from December 2024 to February 2025.

Experimental design and treatments

The experiment was laid out using a Randomized Complete Block Design (RCBD) with seven treatments replicated three times, giving a total of 21 experimental units. A total experimental area of 160 m² was prepared and divided into plots measuring 1 m × 5 m with 0.5 m pathways between plots.

The treatments consisted of different concentrations of vermicast mixed in 8 liters of water for vermitea preparation. The treatments were as follows:

T1 – Control
T2 – 130 g vermicast per 8 L water
T3 – 430 g vermicast per 8 L water
T4 – 730 g vermicast per 8 L water
T5 – 940 g vermicast per 8 L water
T6 – 1,150 g vermicast per 8 L water
T7 – 1,360 g vermicast per 8 L water

Preparation of the experimental area

The experimental area was cleaned thoroughly before land preparation. Weeds and unwanted materials were removed manually, after which the soil was cultivated and pulverized to improve aeration and facilitate root penetration. Plot boundaries and pathways were then established according to the experimental layout.

Seedling production and transplanting

Chinese cabbage (*Brassica rapa* L. var. *pekinensis*) seeds were sown in seedling trays containing a growing medium composed of 50% garden soil, 30% carbonized rice hull, and 20% compost. The trays were placed under a partially shaded area and watered regularly to maintain adequate moisture for germination and seedling growth. One week after germination, the seedlings were gradually exposed to sunlight to acclimatize them to field conditions. Transplanting was carried out 18 days after germination when the seedlings had already developed at least three true leaves. The seedlings were transplanted in the late afternoon to minimize transplanting shock and reduce moisture loss.

Preparation and application of vermitea

Vermitea was prepared by mixing the required amount of vermicast with non-chlorinated water according to the assigned treatment levels. The mixture was allowed to stand for 24 hours to facilitate extraction of nutrients and beneficial compounds from the vermicast. After extraction, the solution was filtered using a 2 mm sieve to remove coarse particles.

A drip fertigation system was installed in the experimental area, wherein each treatment had a designated drip line connected to its corresponding container. The prepared vermitea was mixed with 20 liters of irrigation water and thoroughly stirred to ensure uniform nutrient distribution before application.

The fertigation treatments were applied in eight equal splits at seven-day intervals following the procedure described by Nikzad *et al.* (2020). Application of vermitea started 14 days after transplanting.

Data gathered

Data were collected from selected sample plants in each treatment. The parameters measured included number of leaves, leaf diameter, plant height, plant diameter, plant weight, number of heads per plot, weight of marketable plants per plot, weight of non-marketable plants per plot, and yield expressed in tons per hectare.

Statistical analysis

All data gathered were subjected to analysis of variance (ANOVA) appropriate for RCBD to determine the significance of treatment effects. Treatment means were compared at the 5% level of significance.

RESULTS AND DISCUSSION

Number of leaves

The number of leaves of Chinese cabbage was not significantly influenced by the different concentrations of vermitea applied through drip fertigation (Table 1). Mean values ranged from 25.40 leaves in the control treatment to 28.30 leaves in T6 (1,150 g vermicast per 8 L of water). Although T6 produced the highest numerical mean, the variation among treatments was not sufficient to produce significant differences, as confirmed by the ANOVA results (Table 10).

The results suggest that the concentrations of vermitea used in the study were unable to substantially stimulate vegetative leaf production under the existing field conditions. Chinese cabbage is highly responsive to environmental conditions, particularly temperature and soil nutrient availability. During the conduct of the experiment, fluctuating temperature and field stress may have limited nutrient absorption and plant response. Mishra *et al.* (2023) explained that heat stress can

interfere with nutrient uptake and assimilation, reducing vegetative growth even when nutrients are available. In contrast, Rogelio (2017) reported improved leaf production in sweet corn following vermitea application, indicating that crop response may vary depending on crop type, environmental conditions, and nutrient demand.

Table 1. Total and mean of number of leaves (pieces) for each treatment

Treatment	Total	Mean
T1	76.20	25.40
T2	80.90	26.97
T3	77.80	25.93
T4	76.70	25.57
T5	77.70	25.90
T6	84.91	28.30
T7	80.20	26.73

Leaf diameter

Leaf diameter was likewise not significantly affected by the different fertilizer treatments (Table 2). Mean leaf diameter ranged from 18.69 cm in T5 to 19.70 cm in T3, showing only minimal variation among treatments. The computed F-value remained lower than the tabular value at the 5% level, confirming the absence of significant differences (Table 10).

Table 2. Total and mean of leaf diameter (cm) for each treatment

Treatment	Total	Mean
T1	57.57	19.19
T2	57.92	19.31
T3	59.11	19.70
T4	58.18	19.39
T5	56.06	18.69
T6	58.98	19.66
T7	58.07	19.36

Although some treatments showed slightly wider leaves, the differences were too small to indicate a meaningful treatment effect. Leaf expansion in Chinese cabbage is strongly influenced by environmental conditions and nutrient availability. Under warm lowland conditions, plants often experience reduced cell expansion and increased moisture stress, which can limit leaf development. Kumara *et al.* (2021) emphasized that climatic conditions greatly affect crop growth and productivity in tropical environments. The findings of the present study differ from those of Simeon and Bugawisan (2023), who observed improved leaf width in pechay treated with vermitea. Such variation may be due to differences in growing environment, crop species, and nutrient concentration.

Plant height

Plant height did not vary significantly among treatments (Table 3). Mean plant height ranged from 25.85 cm in T4 to 29.22 cm in T2. Although T2 recorded the tallest plants, statistical analysis showed that the treatments did not significantly influence plant height (Table 10).

Table 3. Total and mean of plant height (cm) for each treatment

Treatment	Total	Mean
T1	84.13	28.04
T2	87.67	29.22
T3	85.58	28.53
T4	77.56	25.85
T5	83.92	27.97
T6	86.06	28.69
T7	81.50	27.17

The relatively similar plant height observed across treatments suggests that the vermitea concentrations applied through drip fertigation were insufficient to produce a strong growth response. Plant height is closely associated with nutrient uptake efficiency and environmental conditions. High temperature commonly experienced in tropical areas can reduce physiological activity and restrict plant growth. Mishra *et al.* (2023) noted that heat stress negatively affects nutrient transport and assimilation in plants, resulting in reduced vegetative development. Musa *et al.* (2017), however, reported increased plant height in spinach treated with vermitea, while Nikzad *et al.* (2020) observed improved growth performance in fertigated cabbage. The contrasting results may indicate that environmental conditions played a major role in limiting crop response in the present study.

Plant diameter

The application of different vermitea concentrations did not significantly affect plant diameter (Table 4). Mean values ranged from 20.19 cm in T3 to 21.63 cm in T2, with only slight variation among treatments. ANOVA further confirmed that the treatments were statistically comparable (Table 10).

Table 4. Total and mean of plant diameter (cm) for each treatment

Treatment	Total	Mean
T1	61.88	20.63
T2	64.90	21.63
T3	60.56	20.19
T4	64.56	21.52
T5	60.88	20.29
T6	62.23	20.74
T7	64.19	21.40

The absence of significant differences suggests that stem and canopy expansion were not greatly influenced by the applied treatments. Environmental stress, particularly elevated temperature, may have reduced biomass accumulation and carbon metabolism, thereby limiting plant development. Jia *et al.* (2015) reported that high temperature conditions can alter plant physiological processes and suppress growth performance. Although fertigation has been shown to improve stem development in some vegetable crops (Kanwar and Sonkamble, 2024), the present findings indicate that the vermitea concentrations used were not enough to generate a measurable response in Chinese cabbage under the prevailing conditions.

Plant weight

Plant weight was also not significantly affected by the fertilizer treatments (Table 5). Mean plant weight ranged from 738.67 g in T6 to 921.17 g in T5. While T5 numerically produced heavier plants, the differences among treatments remained statistically non-significant based on the ANOVA results (Table 10).

Table 5. Total and mean of plant weight (g) for each treatment

Treatment	Total	Mean
T1	2310.70	770.23
T2	2583.10	861.03
T3	2227.50	742.50
T4	2609.90	869.97
T5	2763.50	921.17
T6	2216.00	738.67
T7	2677.70	892.57

The lack of significant improvement in plant biomass may indicate that nutrient availability from the vermitea treatments was insufficient to support substantial growth enhancement. Environmental factors may have also contributed to the limited response. High temperature stress is known to suppress photosynthesis and reduce dry matter accumulation in plants (Zhang *et al.*, 2016). Similarly, Zhang *et al.* (2022) emphasized that lower nutrient availability from organic fertilizers may not always satisfy crop nutrient requirements. In contrast, Besas *et al.* (2020) observed increased plant biomass in lettuce treated with vermitea, suggesting that the effectiveness of organic fertigation may depend on crop adaptability and environmental suitability.

Number of heads per plot

The number of heads per plot was not significantly influenced by the different treatments (Table 6). Mean values ranged from 4.67 heads in T1 and T6 to 8.67 heads in T7. Although T7 numerically produced the highest number of heads, statistical analysis revealed no significant differences among treatments (Table 10).

Table 6. Total and mean of number of heads per plot (pieces) for each treatment

Treatment	Total	Mean
T1	14.00	4.67
T2	22.00	7.33
T3	20.00	6.67
T4	21.00	7.00
T5	24.00	8.00
T6	14.00	4.67
T7	26.00	8.67

Head formation in Chinese cabbage is highly sensitive to temperature and environmental stress. Excessive heat can interfere with proper head initiation and development, leading to reduced yield performance. Moradpour *et al.* (2021) explained that high temperature negatively affects head formation in Brassica crops. This may explain why the treatments failed to produce significant differences despite some numerical variation. Previous studies by Hamed *et al.* (2022) and Vethamoni and Shivalkar (2018) reported improved head formation under vermicompost tea application and fertigation management, respectively. However, the field conditions during the conduct of the study may have limited the positive effects of the treatments.

Weight of marketable plants per plot

The weight of marketable plants per plot did not significantly differ among treatments (Table 7). Mean

values ranged from 112.50 g in the control treatment to 222.50 g in T7. Although T7 produced the highest marketable weight, the variation among treatments remained statistically non-significant (Table 10).

Table 7. Total and mean of weight of marketable per plot (g) for each treatment

Treatment	Total	Mean
T1	337.50	112.50
T2	546.38	182.13
T3	538.02	179.34
T4	508.00	169.33
T5	549.87	183.29
T6	547.63	182.54
T7	667.50	222.50

The results indicate that the applied vermitea concentrations were unable to consistently improve marketable yield under the prevailing conditions. Environmental stress may have reduced photosynthetic efficiency and plant productivity, thereby affecting marketable head development. Hasanuzzaman *et al.* (2017) reported that elevated temperature can induce oxidative stress in plants, reducing overall productivity. Despite the absence of significant differences, the higher numerical values observed in T7 may suggest a slight positive response to higher vermicast concentration, although this response was not strong enough to be statistically detected.

Weight of non-marketable plants per plot

The weight of non-marketable plants per plot was likewise not significantly affected by the treatments (Table 8). Mean values ranged from 459.10 g in T7 to 585.35 g in the control treatment. Statistical analysis showed that the treatments did not significantly influence the amount of non-marketable plants produced (Table 10).

Table 8. Total and mean of weight of non-marketable per plot (g) for each treatment

Treatment	Total	Mean
T1	1756.06	585.35
T2	1678.00	559.33
T3	1574.82	524.94
T4	1742.19	580.73
T5	1434.69	478.23
T6	1547.88	515.96
T7	1377.29	459.10

Several non-marketable plants were observed to be damaged by insect infestation and poor head formation. Warm environmental conditions likely favored insect activity, which may have contributed to reduced crop quality. Abang *et al.* (2014) noted that tropical conditions with elevated temperature commonly promote insect population growth in vegetable crops. Furthermore, heat stress may have weakened plant physiological function and nutrient uptake, leading to poor head development and reduced market quality (Giri *et al.*, 2017; Moradpour *et al.*, 2021).

Yield (t ha^{-1})

Yield expressed in tons per hectare was not significantly affected by the application of different vermitea concentrations (Table 9). Mean yield ranged from 1.18 t ha^{-1} in T6 to 1.50 t ha^{-1} in T4. Despite observable numerical variation, statistical analysis confirmed that the treatments did not significantly influence yield performance (Table 10).

Table 9. Total and mean of yield (t ha^{-1}) for each treatment

Treatment	Total	Mean
T1	3.78	1.26
T2	4.19	1.40
T3	4.09	1.36
T4	4.49	1.50
T5	4.07	1.36
T6	3.55	1.18
T7	4.02	1.34

The findings suggest that the levels of vermitea applied through drip fertigation were not sufficient to produce a measurable increase in Chinese cabbage productivity. Seasonal environmental conditions may have strongly influenced crop performance during the experiment. Variations in temperature, solar radiation, and relative humidity can greatly affect photosynthesis, nutrient utilization, and yield formation in vegetable crops (Kumara *et al.*, 2021). Although previous studies such as those of Besas *et al.* (2020) and Ayas (2021) reported positive effects of vermitea and fertigation on vegetable yield, the present study indicates that environmental stress and limited nutrient response may have reduced treatment effectiveness under low nutrient field conditions.

Table 10. One-way ANOVA for different characters

Characters	Computed F	Tabular F (5%)	Significance
Number of leaves	2.88	3.00	Not significant
Leaf diameter	0.25	3.00	Not significant
Plant height	1.83	3.00	Not significant
Plant diameter	0.35	3.00	Not significant
Plant weight	0.71	3.00	Not significant
Number of heads per plot	0.73	3.00	Not significant
Weight of marketable plants per plot	1.03	3.00	Not significant
Weight of non-marketable plants per plot	0.51	3.00	Not significant
Yield (t ha^{-1})	0.43	3.00	Not significant

CONCLUSION

The study revealed that the different concentration levels of vermicast per 8 liters of water applied through drip fertigation did not significantly influence the growth and yield performance of Chinese cabbage under low nutrient field conditions. Parameters such as number of leaves, leaf diameter, plant height, plant diameter, plant weight, number of heads per plot, weight of marketable plants, weight of non-marketable plants, and yield in tons per hectare showed no significant differences among treatments. Although some treatments produced slightly higher numerical values, the variations were not statistically sufficient to indicate a consistent treatment effect. The findings suggest that the vermitea concentrations used in the experiment may not have supplied enough available nutrients to substantially improve crop performance under the prevailing environmental conditions. In addition, factors such as high temperature, pest infestation, and environmental stress may have limited nutrient utilization and plant development during the conduct of the study. Further studies using higher nutrient concentrations, improved environmental management, and longer evaluation periods are recommended to better determine the potential of vermitea applied through drip fertigation in Chinese cabbage production.

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