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## Effects of Vermicompost on the Growth and Antioxidant Property of Grand Rapid Lettuce (*Lactuca sativa* L.)

S. A. P. Mala<sup>1\*</sup>

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### ABSTRACT

Vermicompost as organic fertilizer is unpopular among farmers in Lanao del Sur and Marawi City. Thus, introduction of organic farming to majority of the farmers and vegetable growers needs to be strengthened. Taking this into consideration, this study was conducted to determine the effect of vermicompost as organic fertilizer on lettuce focusing on growth, yield, antioxidant property as well as incidence of insect pests and diseases. The study utilized Randomized Complete Block Design (RCBD) with three replications. Crops were established by directly sowing the seeds to the pots with fertilizer and control treatments. Fourteen (14) days after sowing (DAS), all lettuce grown with vermicompost had significantly higher germination percentage compared to plants grown under control and chemical fertilizers. The leaves of lettuce grown with vermicompost were longer and wider during the four (4) weeks while those that were chemically fertilized outperformed organically grown plants on its fifth week until reap. The distinction became critical only during its 6th week. As a result, plants treated with chemicals had significantly heavier weight resulting to significant higher yield compared to those grown under organic fertilizer and control treatments. However, in terms of antioxidant property of lettuce particularly vitamin C, plants applied with vermicompost had significantly higher antioxidant content contrasted with plants treated with chemical fertilizer. Moreover, on pest and disease damage, plants were not significantly affected by the kinds of fertilizer utilized while the occurrence of diseases and pest infestation were found low in all treatments. Considering these outcomes, organic production of lettuce using vermicompost is recommended. Further experiment utilizing various doses of vermicompost in mix with biofertilizers using different varieties of lettuce is likewise proposed.

### INTRODUCTION

Lettuce (*Lactuca sativa* L.) is the most popular salad crop grown on a commercial scale. It has great health benefits primarily because it is rich in antioxidants such as Vitamin C which is anti-carcinogenic. The nutritional components of lettuce vary from one variety to another, but the most important requirement of this crop for better growth and yield is the use of fertilizers either organic or inorganic form.

It has been a common agricultural practice to utilize mineral fertilizers when it comes to growing lettuce as it brings satisfactory yield. However, the consumers' health, product quality and product cost shall be given considerations especially that organic farming is being promoted and encouraged for more sustainable farming. Extreme and continuing use of synthetic and chemical products in agriculture advances an issue of concern for the various complications it causes, including but not restricted to the degree of contaminations that the crop may contain, decline in soil fertility, soil and groundwater pollution through the disproportionate use of nitrogen fertilizers like urea (Hernandez et al., 2010). Moving to organic farming by applying organic fertilizer for lettuce is vital to produce longer and wider leaves, higher shoot, and brings down the grouping of nitrate while inorganic nitrogen composts are the principal type of the component consumed by most plant (Colleen, 2018).

In the Philippines, study shows that the country's production of lettuce in 2016 up to 2020 exhibited average annual increase of 4.3 percent. Lettuce is predominantly grown in CAR (Benguet) and Northern Mindanao (Bukidnon). The production in Northern Mindanao in 2020 was 1,717 mt from a production area of 150 hectares and the whole country had produced 4,360 mt from 499 hectares.

The statistics above attests the need to produce more lettuce because of its increasing demand from farmers' markets, supermarkets, hotels, restaurants, fast-food chains, and high-end food service companies. It is necessary to find best alternatives to do convenient agricultural practices without compromising the food nutritional properties. On the other hand, there has to be an adoption of sustainable agricultural strategies and techniques to sustain the environmental preservation while gaining a huge quantity of agricultural products. Further, in consideration of the sustainability, absence of chemical fertilizers and synthetic pesticides, as well as the enhanced physico-chemical and micro-biological soil fertility, it is notable that organic farming presents more benefits compare to conventional approach when it comes to all the terms mentioned earlier.

Thus, this study aspired to promote a production system that sustains the health of soils, ecosystems and people. It was conducted to determine the effect of vermicompost

<sup>1</sup> Department of Agricultural Education and Extension, College of Agriculture, Mindanao State University-Main Campus, Marawi City, Lanao del Sur 9700, Philippines

\* Corresponding author's e-mail: [sittyaynah.mala@msumain.edu.ph](mailto:sittyaynah.mala@msumain.edu.ph)

and inorganic fertilizer on the growth and total antioxidant content of lettuce in terms of vitamin C. Moreover, it aimed to determine the influence of the aforementioned factor in pests and diseases of lettuce raised in container.

## MATERIALS AND METHODS

A pot experiment was conducted in the College of Agriculture, Mindanao State University-Main Campus, Marawi City, Lanao del Sur from August to September 2018 to determine the effect of vermicompost on lettuce in terms of their growth and antioxidant property as well as their effect on the insect pests and diseases. The study was laid out in a Randomized Complete Block Design (RCBD) with two kinds of fertilizers as treatments and replicated three times. Vermicompost was used as the organic fertilizer and complete fertilizer (14-14-14) as the chemical fertilizer. Thus, the different treatments were: T1 (Vermicompost), T2 (14-14-14) and T3 (Control), Each treatment or plot consisted of fifteen (15) pots which made a total experimental unit of 135 pots. Randomization was done through drawing of lots in all plots using uniform-size pieces of paper. The lay-out was done following the step-by-step procedure in RCBD factorial experiment.

### Crop Establishment

The pots used were thick black polyethylene plastic containers with 8 inches diameter. These are affordable, durable, lightweight and accessible in the local market. Pots were prepared by filling in ordinary garden soil. Fertilizers were applied one day before planting. The seeds were directly sown in the prepared pots on the same day. They were covered lightly with no more than ¼ inch of soil.

### Cultural and Pest Management Practices

#### Materials

The variety of lettuce used in this study was Grand Rapids. It is widely adaptable and can be grown well in cooler seasons. Plants mature at 45 days after sowing.

The study applied the recommended rate of fertilizer for lettuce. For vermicompost, 50 grams per pot was applied as basal fertilizer. And for inorganic, 6.4 grams of complete fertilizer (14-14-14) per pot was applied.

The crops were monitored daily if there was an incidence of diseases and presence of insect pests. Weeds were manually uprooted to avoid competition to sunlight, nutrients and soil moisture. Water was provided to the crops three to four times a week when there was no occurrence of natural rainfall using sprinkler. The length and width of leaves were measured on the 3rd, 4th 5th and 6th week after sowing. Harvesting was done forty-five (45) days after sowing.

### Data Gathered

#### Growth Parameters

1. Germination percentage – was observed fourteen days after sowing (DAS). This was measured using the

formula:

$$\% \text{ Germination} = (\text{Number of Seed Germinated} / \text{Total Number of Seeds Sown}) \times 100$$

2. Length and width of leaves - was determined by measuring the length and width of the leaves every seven (7) days. The fully developed leaf in the data plant was chosen for measurements of the leaf length and width.

### Yield

3. Total weight of plants (kg) - was taken by weighing the total plants harvested in each plot by grams.

### Pest and Disease Damage Rating

This was done by monitoring the crops daily if there is an incidence of diseases and presence of insect pests. The damage rating was determined based on the following rating scales:

1-2	Low
3-4	Moderate
Above 5	Severe

### Total Antioxidant Property of Lettuce

Fresh lettuce crops harvested from different treatments were subjected to chemical test at the laboratory of the College of Natural Sciences and Mathematics, Mindanao State University – Marawi. The total antioxidant activity of lettuce sample was estimated using phosphomolybdenum assay. The washed and clean lettuce plant (stem and leaves) was manually extracted (without adding any extracting solvent) using mortar and pestle and filtered into a test tube. From the filtered lettuce extract, a volume of 100, 200, 300, 400 and 500 µl was separately transferred into 5 different test tubes containing 1 µl of the freshly prepared molybdate reagent solution. Consequently, distilled water was added to each of the test tubes to make up a total volume of 5 µl and was homogenized using the vortex. The test tubes were kept incubated at 95 Celsius for 90 minutes. After the incubation, the tubes were normalized to room temperature for 20-30 minutes before the absorbance of the reaction mixture was measured in the UV-Vis Spectrophotometer at 695 nm wavelength.

### Data Analysis

All data gathered in this study were tabulated and statistically analyzed using the Analysis of Variance (ANOVA). The data with significant and highly significant results are subjected to Least Significance Difference (LSD) Test in Statistical Tool in Agricultural Research (STAR) Version: 2.0.1 to determine the significant differences among treatment means.

## RESULTS AND DISCUSSION

### Germination Percentage

Table 1 shows that lettuce plants grown under organic fertilizer had significantly higher germination percentage ( $p > 0.05$ ) compared to plants grown under control and chemical fertilizers, where: T1 (organic treatment) 74.56%, T3 (control treatment) 68.58%, and T2 (chemical

treatment) 58.13% respectively. Germination requires favorable environment which includes adequate water and suitable temperature to break seed dormancy. The significantly higher germination percentage recorded from organic treatments may be attributed to several factors such as soil temperature and moisture. The high soil temperature in pots applied with chemical fertilizer caused the low germination of lettuce. It was observed that the granular chemical fertilizers were not fully decomposed two weeks after application thereby causing

high temperature. It was also observed that pots treated chemically were prone to soil clogging. On the other hand, vermicompost improves soil aeration and water holding capacity. Pots treated with vermicompost were moist and well-drained. According to Firefly (2008), the expansion of vermicast has reliably further developed seed germination, upgraded seedling development and improvement more than the change of mineral supplements into more plant accessible structures.

**Table 1:** Germination percentage

Variety	Fertilizer		
	Vermicompost	Inorganic	Control
Grand Rapid	74.56 <sup>a</sup>	58.13 <sup>b</sup>	68.58 <sup>ab</sup>

*In the same row, means followed by a common letter are not significantly different at 5% level by LSD test.*

### Leaf Length

Table 2 presents the leaf length of lettuce days after sowing. At 21 DAS, lettuce plants grown under organic fertilizer were significantly longer ( $p > 0.05$ ) compared to plants grown under control and chemical fertilizers, where: T1 (organic treatment) 4.68 cm; T2 (chemical treatment) 3.38 cm; and T3 (control treatment) 1.56 cm, respectively. And at 28 DAS, lettuce plants grown under organic fertilizer were significantly longer ( $p > 0.05$ ) compared to plants grown under control and chemical fertilizers, where: T1 (organic treatment) 6.20 cm; T2 (chemical treatment) 4.93 cm; and T3 (control treatment) 2.62 cm, respectively.

The better performance of organically grown lettuces could be attributed to the plant growth hormones present in vermicompost. As indicated by the investigation of Arancon and Edwards (2005), vermicompost contains humates and growth hormones like auxins, gibberellic acids and cytokinins. Among them, auxins capability for the advancement of the development of plant's length. They make the recently shaped leaves develop longer. One more review directed by Arguello et al. (2013) detailed that vermicompost expanded development in lettuce is probably because of an expanded action of the ground meristem of the leaf edge which relates to an expansion in the photosynthetic activity. Further, the discoveries of Hernandez et al (2007) uncovered that the option of vermicompost on lettuce showed more noteworthy growth during the first four (4) weeks when contrasted with plants added with inorganic manure.

However, at 35 DAS the leaf length of lettuce treated with chemical fertilizer surpassed plants grown under organic fertilizer 35 days after sowing, where: T2 (chemical) 8.28 cm, T1 (organic) 7.97 cm, and T3 (control) 4.05 cm, respectively. This result may be

attributed to the availability and accessibility of nutrients necessary for plant growth and development. After 5 weeks of application, the granular chemical fertilizer was fully transformed into soluble form which made them available for plant absorption. On the other hand, the nutrients in vermicompost were utilized at the early stage of lettuce growth. Thus, plants under chemical treatment showed higher increase in leaf length.

At 42 DAS, lettuce plants treated with chemical fertilizer were significantly longer ( $p > 0.05$ ) compared to control and organically treated plants where: T2 (chemical) 11.87 cm, T1 (organic) 9.47 cm, and T3 (control) 5.91 cm, respectively. The fertilizer mean showed that inorganic treatment (7.12) was comparable to organic (7.08). This result conformed to the findings of Hernandez et al. (2007) that after 5 weeks, plant growth and development in inorganic exceeded organic which showed a small increase in growth and development during the following 3 weeks. Similarly, Leon (2012) figured out that at harvest, vermicompost had no effect on leaf region.

### Leaf Width

Table 3 shows the leaf width of lettuce days after sowing. At 21 DAS, lettuce plants treated with organic fertilizer were significantly wider ( $p > 0.05$ ) compared to control and chemically treated plants where: T1 (organic) 3.81 cm, T2 (chemical) 2.75 cm, and T3 (control) 1.65 cm, respectively. And at 28 DAS, lettuce plants treated with organic fertilizer were significantly wider ( $p > 0.05$ ) compared to control and chemically treated plants where: T1 (organic) 5.04 cm, T2 (chemical) 4.18 cm, and T3 (control) 2.45 cm, respectively.

The use of vermicompost of 50 g/plant fundamentally impacted the width of lettuce plants. This outcome is in concurrence with the investigation of Ali et al. (2007)

**Table 2:** Mean leaf length (cm)

Variety	Fertilizer	Days After Sowing (DAS)				MEAN
		21	28	35	42	
Grand Rapid	Vermicompost	4.68	6.20	7.97	9.47	7.08
	Inorganic	3.38	4.93	8.28	11.87	7.12
	Control	1.56	2.62	4.05	5.91	3.54

**Table 3:** Mean leaf width (cm)

Variety	Fertilizer	Days After Sowing (DAS)				MEAN
		21	28	35	42	
Grand Rapid	Vermicompost	3.81	5.04	6.28	7.74	5.72
	Inorganic	2.75	4.18	6.96	9.32	5.80
	Control	1.65	2.45	3.64	4.96	3.18

that utilization of vermicompost expanded lettuce height and dry weight. Additionally, the review led by Cervantes et al. (2017) uncovered that growth and yield of lettuce plants from suggested organic system performed much the same way with farmers' current organic production system were superior to conventional system

However, at 35 DAS leaf width of lettuce plants applied with chemical fertilizer was comparable to plants treated with organic fertilizer but were significantly wider than unfertilized plants, where: T2 (chemical) 6.96 cm, T1 (organic) 6.28 cm, and T3 (control) 3.64 cm, respectively. And at 42 DAS, lettuce plants treated with chemical fertilizer were significantly wider ( $p > 0.05$ ) compared to control and organically treated plants where: T2 (chemical) 9.32 cm, T1 (organic) 7.74 cm, and T3 (control) 4.96 cm, respectively. The fertilizer mean for leaf width showed that inorganic treatment (5.80) was comparable to organic (5.72).

The clarification behind these discoveries is like leaf length 42 DAS as provided earlier. This outcome is conversely, with the findings of Liu et al. (2014) that lettuce filled in organic fertilizer-treated soil has better growth contrasted with inorganic manure. Likewise, the investigation of Saha (2016) uncovered that the more significant level of organic excrements especially as vermicompost

meaningfully affects plant height of lettuce at harvest. Further, Hossain and Ryu (2017) presumed that growth and yield of lettuce were the most elevated in suggested dose of organic fertilizer.

**Total Weight**

The total weight of lettuce was obtained 45 days after sowing (DAS). Table 4 shows that lettuces grown under chemical fertilizer had the highest average yield of 0.300 kg compared to organically fertilized plants (0.207 kg). Unfertilized lettuces had the lowest yield of 0.047 kg.

As discussed earlier, chemically treated plants had significantly longer and wider leaves compared to plants grown under organic treatments and unfertilized plants 42 days after sowing, which was 3 days before harvest. Obviously, plants with heavier total weight had significantly higher yield.

This perception is like the discoveries of Hernandez et al. (2007) that load of the collected lettuce showed huge contrasts for inorganic when contrasted with organic treatments. León et al. (2012) likewise reasoned that marketable yield was not impacted by vermicompost application conversely, other researchers tracked down more significant returns with the use of organic fertilizer (Hossain & Ryu, 2017; Saha, 2016).

**Table 4:** Germination percentage

Variety	Fertilizer		
	Vermicompost	Inorganic	Control
Grand Rapid	0.207 <sup>B</sup>	0.300 <sup>A</sup>	0.047 <sup>C</sup>

*In the same row, means followed by a common letter are not significantly different at 5% level by LSD test.*

**Pest and Disease Damage Rating**

Pest and disease damage were not significantly affected by different types of fertilizer and variety. Among the 135 lettuce plants grown, only three plants or 2% was seen to be infested by pests. Aphids, leaf miner and cutworm (*Agrotis* spp.) were observed to be feeding on the leaves. These insects are the most common pests of lettuce. On the other hand, only tipburn was observed infecting the outer and mature leaves. Using the rating scale, all the treatments have low (1-2) damage rate.

This observation may be due to the environmental condition the lettuce crops were exposed to. The site of the field experiment and the pot culture lessened the entry of insect pests. The net shade also protected the crops from heavy rains and from direct heat of the sun which prevented diseases that can be caused by too much sunlight and too much water. Further, lettuces and a few white scallion on pots were the only crops present on the site. Thus, no neighboring crops became a source of insects and viruses.

Good farm hygiene was also a factor. It reduced the risk of bringing new infections into the site of experiment. The door to the rooftop was always closed, hence other people were restricted to enter. Only the researcher and her two assistants had the access on the site. Thus, the risk of potential carriers of pests were controlled. In addition, weeds which can serve as hosts for pests and viruses were controlled in container gardening method of cultivation.

**Total Antioxidant Property**

The total antioxidant property of lettuce was estimated using phosphomolybdenum assay and vitamin C or ascorbic acid as standard. As shown in Table 5, lettuce grown under organic treatments have significantly higher (1.44) vitamin C compared to other treatments. Smallest (0.40) absorbance of vitamin C was observed in unfertilized plants.

This observation concurs with the discoveries of Silva et al. (2018) that organic lettuce showed higher viability in antioxidant capacity and more elevated levels of phenolic compounds than conventionally grown lettuce. Also,

the investigation of Ismail & Fun (2003) revealed that organically grown lettuce had significantly higher ascorbic acid content than conventionally grown ones. However, this in as opposed to the discoveries of de Oliveira Pereira et al. (2016) that the conventional lettuce samples

had a higher ascorbic acid value than organic and certified organic samples. The contrast between these outcomes might be credited to the utilization of various cultivars and natural circumstances where the examinations were conducted. The openness of plants to both biotic and

**Table 5:** Total antioxidant property (Vitamin C)

Variety	Fertilizer		
	Vermicompost	Inorganic	Control
Grand Rapid	1.44 <sup>A</sup>	1.04 <sup>B</sup>	0.40 <sup>C</sup>

*In the same row, means followed by a common letter are not significantly different at 5% level by LSD test.*

abiotic stress might add to the more noteworthy impacts of antioxidant activity. Further, Kim et al. (2018) found that both cultivation and color of lettuce can change the phenol content and antioxidant activities. Therefore, the degrees of phenolic mixtures and antioxidant activities can change contingent upon the genetic material, applied management and climatic conditions utilized.

## CONCLUSION

The results of this study confirmed the positive effects of vermicompost as organic fertilizer on grand rapid lettuce. Basal application of vermicompost at 50 grams per pot positively influenced seed germination and seedling development. However, chemical fertilizer worked better at the later stage of lettuce growth. Thus, higher yield values were obtained from plants under chemical treatments. In terms of antioxidant property, organically grown lettuce reflected highest absorbance of antioxidants particularly on Vitamin C. All treatments recorded low occurrence of diseases and pest infestation. Therefore, organic production of lettuce using vermicompost is recommended. Further experiment using different dosages of vermicompost in combination with biofertilizers using other varieties of lettuce is also suggested.

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