Growth Performance of Economically-Important Plants Using Vermicompost Derived from Kibalisa Eco-waste Center

Hazel R. Balan[1], Jonrick G. Escol[2], Jessanto L. Baranggan[3], Canna Regine D. Cubao[4],

FACULTY-Gingoog City Comprehensive National High School, Gingoog City, Philippines[1]
Ph.D. Student-Caraga State University, Ampayon, Butuan City, Philippines[1]
Gingoog City Comprehensive National High School, Gingoog City, Philippines[2, 3, 4]

DOI: 10.29322/IJSRP.9.03.2019.p8799
http://dx.doi.org/10.29322/IJSRP.9.03.2019.p8799

Abstract: Vermicompost refers to a comprehensive soil substrate and an eco-friendly farm input. It is produced by the joint and simultaneous action of earthworms and microorganisms in degrading organic matter into nutritional humus in the absence of heat. This study was carried out to determine the growth performance of selected plants using vermicompost derived from Kibalisa Eco-waste Center. A total of three treatments were carried out in the experimentation for a period of 45 days. Three plants in 10 replicates were selected for the experimentation namely; mung bean (*Vigna radiata*), tomato (*Solanum lycopersicum*) and petchay (*Brassica rapa*). Plant height (cm), stem diameter (cm), root length (cm), number of leaves, and leaf area (cm^2) were measured using a measuring tape and the data gathered were subjected into statistical analysis using One-way ANOVA test. Results revealed that treatments with vermicompost showed a significant difference compared to control ($p<0.05$) in terms of growth parameters. However, both treatments with vermicompost did not disclose significant difference ($p>0.05$). This study suggests to add more days in conducting the experimentation. Other parameters should also be added such as the yield, fresh and dry weight.

Keywords: Kibalisa Eco-waste Center, Growth Performance, Plants, Vermicompost

INTRODUCTION

Today's agricultural sector seems unsustainable due to intensive agricultural activities as the current development agenda focus on addressing the daily needs of foods for the ever-growing population (Gonzales et al., 2015). In the Philippines which is an agricultural country, 32% of total land area adheres to agriculture. In 2012, about 37% of the population is involved in agriculture-related practices as stipulated on statistical data from the Bureau of Agricultural Statistics (BAS) of the Department of Agriculture. With 11% being the total share in the Gross Domestic Product (GDP) of the country (BAS, 2012) and P697.2 billion being the gross earnings from agriculture for the first half of 2013, it cannot be denied that agriculture plays a vital role in the Philippine economy (Lualhati & Rodeo, 2013). Though the agricultural sector has a significant share in the economy and even in one's daily living but it also draws negative effects. As one of the current trend and the timeliest agricultural practice that is considered one of the major contributing factor of the deterioration of natural resources is chemical-based farming (Gonzales et al., 2015).

Applying heavy doses and concentrations of chemical fertilizers in farming is put into practice by the farmers to enhance the productivity of their crops (Eswaran & Mariselvi, 2016). However, over usage of these inorganic fertilizers causes unwanted ecological consequences particularly to the soil, vulnerability of pests, and arise of diseases due to excessive supply of nitrogen (Islam et al., 2017). In addition, these farm inputs are expensive and sometimes the availability of supply is limited that majority of the farmers resort to organic farming through the use of organic fertilizers no matter how time-consuming the preparation is (Gonzales, et al., 2015). This kind of fertilizer has the ability to enhance the cation exchange capacity of the soil and its major properties such as chemical, physical, and biological properties which can lead to further improvement in the growth performance of plants (Gonzales et al., 2015).

One such source of organic fertilizers is the vermicompost. It is produced through a heat-free process by the simultaneous actions of earthworms and microorganisms in degrading the organic matter into humus (Abafita et al., 2014). The mesophilic microorganisms take charge for the biochemical degradation of organic matter, while the earthworms are the major workers along the process by breaking down and preparing the substrate, and later altering the biological activity (Olle, 2016).

In the Philippines, the government issued the Republic Act 9003 or the Philippine Ecological Act of 2000 that is to practice an orderly, comprehensive, and ecological solid wastes management program. This upholds environmental protection and health, reduction of wastes through the implementation of composting with the joint collaboration of the residents to produce organic fertilizer for plants to maintain a healthy source of food. Moreover, the Philippine Organic Agriculture Act of 2010 or R.A. 10068 gives emphasis in the implementation of organic agriculture throughout the country to enhance the soil fertility and productivity of crops, decrease pollution and further ecological disruption, prevent degradation of available natural resources, protect human health and avoid imported farm inputs (Becero et al., 2016).

In the Province of Misamis Oriental, the locality of Gingoog City has established an eco-waste center located in Kibalisa, SanJuan, Gingoog City which serves as the depository area of all solid wastes from the entire city. Because of the rapid, inevitable, and uncontrollable wastes production, the Local Government Unit of Gingoog City implemented vermicomposting in the eco-waste center and the end product which is the vermicompost is sold for agricultural use.

Hence, the major purpose of this study lies primarily in utilizing vermicompost derived from Kibalisa Eco-waste Center and determine its growth performance to economically-important plants namely; mung bean (*Vigna radiata*), tomato (*Solanum lycopersicum*) and petchay (*Brassica rapa*).

MATERIALS AND METHODS

A. Protocol Entry

The researchers sought permission from the Local Government Unit (LGU) of Gingoog City. The letters were given to the Department of Agriculture to give permission to the researchers for the free collection of vermicompost. The substrate used which is the vermicompost was collected from the eco-waste center of Gingoog City (8° 51'2.02" latitude; 125° 9'47.03" longitude) at Brgy. San Juan, Kibalisa, Gingoog City. 25 kilograms of vermicompost was collected freely.

B. Soil Analysis

Soil samples with different concentrations of vermicompost: 0%, 15%, and 30% were sent to Brgy. Taguibo, Butuan City and were subjected to soil laboratory analysis. The soil pH, organic matter, available phosphorus, extractable potassium were measured through Potentiometric Method, Walkley-Black Method, Olsen method, and Cold Sulfuric Acid Method respectively.

C. Experimental Site

The research experiment was carried out at Brgy. 23, Gingoog City for the period of 45 days.

D. Sources of Materials

The following plant seeds of mung beans, petchay, and tomato were bought from the city's agricultural farm supply.

E. Seeding Preparation

The seeds were planted in a large medium (e. g. unused basins, pails, and large plastic bags) that can accommodate a large number of seeds. The same seeds were planted together. After 15 days, the seedlings were transferred to another medium, 1 seedling per pot for better growth.

F. Data Collection

Parameters were measured 45 days after emergence (DAE).

1. **Plant Height** (Ngwu, 2016)
   This was done through measuring the length from the base of the plant to the tip of the shoot and the mean of 10 replicates was computed. This was done through the aid of the meter rule.
2. **Number of Leaves**(Ngwu, 2016)
   The number of leaves was determined by counting the total number of leaves, and the mean of 10 replicates was taken.
3. **Leaf Area** (Eswaran & Mariselvi, 2016)
   The leaf area was calculated using the formula
   Actual Area=L x B x K
   - L- Length of the leaf
   - B- Breadth of the leaf
   - K- Constant factor (0.9 for narrow leaves and o.6 for broad leaves).
4. **Root Length** (Eswaran & Mariselvi, 2016)
   The root length was measured from the root collar region to the tip of the root using the centimeter scale (Eswaran & Mariselvi, 2016).
5. **Stem Diameter**
   The stem diameter was calculated through measuring the diameter of the stem in each plant and the mean of 10 replicates was calculated.

G. Statistical Analysis

The data were treated with statistical analysis specifically One-Way ANOVA Test.

H. Photography

Pictures were taken during the experimentation for documentation.

RESULTS

Table 1. Mean values of plant height of selected plants influenced by vermicompost.

Treatments	Average Values Plant Height (cm)		
	Tomato	Mung Bean	Petchay
T_0-Control (100% Soil)	30.9^c	27.9	9.4^c
T_1-(15%vermicompost)	49.0^b	26.7	13.25^b
T_2-(30% vermicompost)	58.4^a	27.43	20.43^a
P-value	.000	NS	.000

P<0.05

Mean values of plant height of selected economically-important plants namely; mungbean, tomato, and petchay exposed to different treatments as follows: T0 (% vermicompost), T1 (15% vermicompost), and T2 (30% vermicompost) (Table 1).

The table revealed that tomato and petchay grown in 30% vermicompost-amended soil manifested the highest plant height with the average values of 58.4 cm and 20.53 cm respectively followed by the 15% vermicompost with the average values of 49.00 cm and 13.25 cm whereas, lowest plant height was evident in control set up (0%) with average values of 30.9 cm and 9. 4 cm respectively. On the other hand, mung bean revealed highest plant height at control set up with an average value of 27.9 cm which is almost the same to 15% with an average value of 27.43 cm while lowest at 30% with 26.7 being the average value. It is shown that the plant height increased significantly with increasing content of vermicompost up to 30%.

Table 2. Mean values of number of leaves of selected plants influenced by vermicompost.

Treatments	Average Values Number of Leaves		
	Tomato	Mung Bean	Petchay
T_0-Control (100% Soil)	26.9^b	13^a	7.1
T_1-(15%vermicompost)	27.8^b	13.4^a	6.88
T_2-(30% vermicompost)	37.4^a	9.0^b	9.0
P-value	.007	.032	NS

P<0.05

Mean values of number of leaves of selected economically important plants namely; mung bean, tomato, and petchay exposed to different treatments as follows: T0 (0% vermicompost), T1 (15% vermicompost), and T2 (30% vermicompost) (Table 2).

The table showed that tomato exhibited the most number of leaves at 30% concentration followed by 15%, while least number of leaves at 0% with average values of 37.4, 27.8, and 26.9 respectively. Mung bean grown in 15% vermicompost- amended soil showed most number of leaves followed by 0% and lowest in 30% with the average values of 13.4, 13, and 9.0 respectively. Furthermore, petchay revealed the most number of leaves at 30% followed by 0% and least number in 15% with the average values of 9.0, 7.1, and 6.88. It is further revealed that the application of vermicompost enhanced the productivity of leaves in the plants.

Table 3. Mean values of leaf area of selected plants influenced by vermicompost.

Treatments	Average Values Leaf Area (cm^2)		
	Tomato	Mung Bean	Petchay
T_0-Control (100% Soil)	5.89^b	15.92	21.05^c
T_1-(15%vermicompost)	25.89^a	33.08	24.82^b
T_2-(30% vermicompost)	24.67^a	27.84	53.53^a
P-value	.000	NS	.000

P<0.05

Mean values of leaf area of selected economically important plants namely; mungbean, tomato, and petchay exposed to different treatments as follows: T0 (% vermicompost), T1 (15% vermicompost), and T2 (30% vermicompost) (Table 3).

The table disclosed that tomato and mung beans grown in15% exhibited the greatest leaf area with the average values of 25.89 cm^2 and 33.08 cm^2 followed with 30% with average values of 24.67 cm^2 and 27.84 cm^2 while least leaf area was evident in 0% with the average values of 5.89 cm^2 and 15.92 cm^2 respectively. On the other hand, petchay showed greatest leaf area at 30% followed by 15% being the next and least leaf area at 0% with the mean values of 53.53 cm^2, 24.82 cm^2, and 21.05 cm^2. The table showed the difference of leaf area in each plant exposed to different treatments and disclosed that the application of vermicompost enhanced the leaf area of plants compared to plants grown in pure soil.

Table 4. Mean values root length of selected plants influenced by vermicompost.

Treatments	Average Values Root Length (cm)		
	Tomato	Mung Bean	Petchay
T_0-Control (100% Soil)	20.07	18.66	10.37
T_1-(15%vermicompost)	25.14	18.63	12.33
T_2-(30% vermicompost)	24.55	16.66	13.06
P-value	NS	NS	NS

P<0.05

Mean values of root length of selected economically important plants namely; mungbean, tomato, and petchay exposed to different treatments as follows: T0 (% vermicompost), T1 (15% vermicompost), and T2 (30% vermicompost) (Table 4).

It is evident in the table that tomato manifested the highest root length at 15% followed by 30% vermicompost-amended soil and lowest in control with the average values of 25.14 cm, 24.55 cm, and 20.07 cm respectively. Moreover, the set up where mung bean showed highest root length was in 0% followed by 15% with values of 18.66 cm and 18.63 cm whereas, lowest root length was evident in 30% with an average value of 16.66. Furthermore, petchay manifested the highest root length at 30% followed by 15% and lowest in 0% with corresponding average values of 13.06 cm, 12.33 cm, and 10.37 cm. The table further showed the difference between the root length of different plants exposed to different treatments of vermicompost.

Table 5. Mean values of stem diameter of selected plants influenced by vermicompost.

Treatments	Average Values		
	Stem Diameter (cm)		
	Tomato	Mung Bean	Petchay
T_0-Control (100% Soil)	0.41^c	0.21	0.44^b
T_1-(15%vermicompost)	0.72^a	0.28	0.59^a
T_2-(30% vermicompost)	0.69^b	0.23	1.01^a
Sig.	.001	NS	.000

P<0.05

Mean values of stem diameter of selected economically important plants namely; mung bean, tomato, and petchay exposed to different treatments as follows: T0 (% vermicompost), T1 (15% vermicompost), and T2 (30% vermicompost) (Table 5).

It was exposed in the table that tomato and petchay grown in 15% vermicompost-containing soil manifested the greatest stem diameter with the average values of 0.72 cm and 0.28 cm. 30% follows with the mean values of 0.69 cm and 0.23 cm, while they showed smallest stem diameter at control with the average values of 0.41 cm and 0.21 cm respectively. On the other hand, petchay manifested the greatest stem diameter at 30% followed by 15% and smallest in control with corresponding average values of 1.01 cm, 0.59 cm, 0.44 cm.

Table 6. Mean values of soil parameters in different treatment

Treatment	Average Values			
	pH	Organic Matter (%)	Available Phospho -rous (ppm)	Extractable Potassium (ppm)
T_0-Control (100% Soil)	6.01^c	2.0^c	108^c	313^c
T_1-(15%vermi-compost)	6.90^b	6.0^b	174^b	842^b
T_2-(30%vermi-compost)	7.22^a	7.0^a	215^a	3016^a
P-value	.000	.000	.000	.000

P<0.05

Mean values of soil pH, organic matter (%), available phosphorous (ppm), and extractable potassium (ppm) of different treatment as follows: T0 (0% vermicompost + 100% pure soil), T2 (15% vermicompost + 85% pure soil) and T3 (30% vermicompost + 70% pure soil) subjected to soil laboratory analysis (Table 6).

It is revealed that as the concentration of vermicompost increases ranging from 0 to 30%, the pH becomes neutral from being slightly acidic (6.01, medium acidic; 6.90, neutral; and 7.22, neutral). In addition, as the content of vermicompost used as substrate increases (0, 15, and 30%), the organic matter content, available phosphorous, and exchangeable potassium also increases with average values: (2%, 6%, 7%); (108ppm, 174ppm, 215ppm); and (313ppm, 842ppm, 3016ppm) respectively.

DISCUSSION

In the present study, the effect of vermicompost on the growth parameters of tomato (*Solanum lycopersium)*, mung beans (*Vigna radiata*), and petchay (*Brassica rapa)* was carried out. Vermicompost pertains to a comprehensive soil substrate and an eco-friendly farm input which can enhance the productivity of the crops and can prevent pest infestation to plants and environmental pollution. It contains a higher value of nutrients available for plants than the traditional compost due to the high rate of mineralization and degree of humification by the work of earthworms (Joshi et al., 2014).

As shown in table 1, plants grown in vermicompost-amended soil showed higher plant height compared to control especially in 30%. This concurred to the result of the study of Joshi and Vig (2010) that the plant height means of vermicompost treatments (VC15, VC30, and VC45) showed a significant difference than the control. This is supported by the fact that vermicompost contains both macro and micronutrients that are essential in enhancing the growth of plants. It also contains nutrients available for plants such as phosphates, nitrates, soluble potassium, and exchangeable calcium.

In addition, the study of Joshi and Vig (2010) presented that the number of leaves has been further observed that treatments with vermicompost (VC15, VC30, and VC45) have the highest number of leaves than the control. This is similar to the result of the present study that that tomato and petchay exhibited the most number of leaves at 30% than the control while mung bean manifested the most number of leaves at 15%. It is further revealed that the application of vermicompost increased the productivity of leaves in the plants.

Results disclosed that tomato and mung bean grown in 15% vermicompost exhibited the greatest leaf area while the least leaf area was evident in 0%. On the other hand, petchay showed greatest leaf area at 30% followed by 15% being the rank 2 and least leaf area at 0%. The table showed the difference of leaf area in each plant exposed to different treatment and disclosed that the application of vermicompost enhanced the leaf area of plants compared to plants grown in pure soil. In the finding of Eswaran and Marselvi (2016), the treatment with vermicompost has the highest leaf area than treatment with organic manure. This is because organic fertilizer such as vermicompost has the capacity to improve the biological, physical and chemical properties of the soil which could lead to the enhancement of the growth and development of plants (Gonzales et al., 2015).

Abafita et al., (2014) theorized that all 10, 20, and 30% treatments with vermicompost have higher length of root than 0 and 40% mixture of vermicompost. This finding supports the present result that tomato manifested the highest root length at 15% followed by 30% vermicompost and lowest in control while petchay showed highest root length in 30% followed by 15% whereas, lowest root length was evident in control. On the other hand, mung beans showed the highest root length at control compared to 15 and 30% however, mung beans grown in 15 and 30% treatments of vermicompost have more number of roots and broader than that of the control. The roots of mung beans in the control set up might seep deeper in the soil for the needs of water compared to 15% and 30% since vermicompost has high ventilation, porosity, and proper drainage, high maintenance power, moisture absorption and high uptake level for water (Mahmoudi et al., 2016).

Moreover, it was exposed in the results that tomato and petchay grown in 15% manifested the greatest stem diameter followed by 30% while they showed the lowest stem diameter at control. On the other hand, petchay manifested the greatest stem diameter at 30% followed by 15% and lowest in control. This concurred to the finding presented by Joshi and Pal Vig (2010) that the average stem diameter of vermicompost treatments (VC15, VC30, and VC45) showed a significant difference than the control treatment.

In this regard, the addition of substrate which is the vermicompost requires an exact amount to ensure the development of growth performance in plants. In the present study, the addition of 15% and 30% of vermicompost in planting selected plants namely; tomato, mung bean, and petchay significantly improved the growth parameters of the said plants.

CONCLUSION

The findings of the study concluded that the application of vermicompost in Kibalisa Eco-waste Center showed better growth performance of plants namely; tomato, mung beans, and petchay particularly on plant height, number of leaves, stem diameter, leaf area, root length, and number of leaves. This study also concluded that in tomato, plant height, and the number of leaves is most effective in 30% vermicompost, while root length, leaf area, and stem diameter were most effective in set-up with 15% vermicompost. In mung beans, effectiveness in the number of leaves, leaf area, and stem diameter is evident in 15%, while the highest plant height and root length were manifested in 30%. On the other hand, 30% of vermicompost is most effective in all parameters of petchay.

ACKNOWLEDGMENT

The researchers would like to extend their heartfelt gratitude and appreciation to the following persons, institutions, and departments who played a very role from the very start in conducting the study all the way to its completion.

First and foremost, we give our truest thanks to our ever loving God Almighty for giving us the undying love, wisdom, and strength to manage and deal with this academic undertaking. We committed, commit, and will commit everything to Him for without Him, we can do nothing.

Special thanks to our research adviser Mrs. Hazel Roque Balan for guiding and instructing us what to do and for sharing her knowledge and expertise in this field. Her encouragement, guidance, and support each day made us sustain this scholastic endeavor amidst difficulties and ended up with success.

Acknowledgment also to Mrs. Maylene Fuentes and the entire ENRU of Gingoog City and Kibalisa Eco-Waste Center in-charge and staff for assisting and providing us their uilized product which we used in our experiment. We are too grateful to them for prioritizing our request despite the temporary unavailability of their product and giving it to us for free instead.

To our ever supportive family and friends who always got behind our back, always made us inspired each day and stand still whenever we face the most challenging moments. We extend our sincerest gratitude to them especially to our parents for supporting us financially. Their love and unending support made us feel so blessed and inspired us to continue our research project and presented it in a colloquium.

This endeavor worth sustaining!

REFERENCES

Abafita, R. T. Shimber, T. & Kebede, T. (2014). Effects of Different Rates Of Vermicompost as Potting Media on Growth and Yield of Tomato (Solanum lycopersicum L.) and Soil Fertility Enhancement. *Sky Journal of Social Science and Environmental Management*, 3(7), 073-077.

Bercero II, D. M., Aranico, E. C., Tabaranza, A. C. E., Acampado Jr, A. F. (2016). Performance of Single and Combined Compost Enhancers in Composting Urban Wastes at the Household Level. *AES Bioflux*, 8(1), 83-92.

Elivira, C., Dominguez, J., Sampedro, L. & Mato, S. (1995). Vermicomposting for the Paper Pulp Industry. *Biocycle*, 36(6), 62-63.

Eswaran, N. &Mariselvi, S. (2016). Efficacy of Vermicompost on Growth and Yield Parameters of *Lycopersicum* *esculentum*(Tomato). *International Journal of Scientific and Research Publications*,6(1), 95-108.

Getnet, M. & Raja, N. (2013). Impact of Vermicompost on Growth and Development of Cabbage, *Brassica oleracea Linn.* and their Sucking Pest, *Brevicoryne brassicae Linn*. (Homoptera: Aphididae). *Research Journal of Environmental and Earth Sciences*, 5(3), 104-112.

Gonzales, L. M. R., Caralde, R. A. &Aban, M. L. (2015). Response of Petchay (Brassica napus L.) to Different Levels of Compost Fertilizer. *International Journal of Scientific an Research Publications,* 5(2), 1-4.

Islam, M. A., Ferdous, G., Akter, A., Hossain, M. M., & Nandwani, D. (2017). Effect of Organic, Inorganic Fertilizers and Plant Spacing on the Growth and Yield of Cabbage. *Agriculture,* 7(31), 1-6.

Joshi, R., Singh, J. &Vig, A. P. (2014). Vermicompost as an Effective Organic Fertilizer and Biocontrol Agent: Effect on Growth, Yield and Quality of Plants. *Reviews in Environmental Science and Bio/Technology*, pp. 1-23.

Joshi, R., Vig, A. P. (2010). Effect on Vermicompost on Growth, Yield and Quality of Tomato (*Lycopersicum esculentum L.*). *African Journal of Basic & Applied Sciences*, 2(3-4), 117-123.

Lualhati, R. A. & Rodeo A. J. (2013). Situation of Postharvest Technology for Fresh Produce in the Philippines. *Research Gate*, p.1-7.

Mahmoudi, S. V. R., Nasri, M., &Azizi, P. (2016). The Effect of Different Type of Vermicompost Organic Fertilizer Litter on Quantitative, Qualitative and Biochemical Characteristics of Green Mung Bean (*Vigna Radiata L.*) in Drought Stress Conditions in Varamin. International Journal of Advanced Biotechnology and Research (IJBR), 7(4), 205-215.

Ngwu, O. E. (2016). Effects of Organic and Inorganic Fertilizers on the Growth and Yield of Physic Nut (Jatropha curcas). *Journal of Advances in Agricultural & Environmental Engineering (IJAAEE)*, 3(10): 131-135.

Olle, M. (2016). Short Communication: The Effect of Vermicompost Based Growth Substrates on Tomato Growth. *Journal of Agricultural Science*, 1(27), 38-41.

Sinha, R. K., Soni, B. K., Agarwal, S., Shankar, B., & Hahn, G.(2013). Vermiculture for Organic Agriculture: Producing Chemical-Free, Nutritive & Health Protective Foods by Earthworms. *Agricultural Science*, 1(1*)*, 17-44.

Saraswathy, N. &Prabhakaran, J. (2014). Efficacy of Vermicompost of Vegetable Market Solid Waste on Growth Responses of Two Cultivars of Tomato (*Lycopersicum esculentum Mill*). International Journal of Current Biotechnology, 2(4), 51-54.

AUTHORS

First Author – Hazel R. Balan, Ph.D. Student- Science Education in Biology, Caraga State University, Ampayon, Butuan City, msciedhrb@yahoo.com

Second Author – Jonrick G. Escol, Science, Technology, Engineering, and Mathematics Student- Senior High school, Gingoog City Comprehensive National High School, Gingoog City, jrick_locse@yahoo.com

Third Author – Jessanto L. Baranggan, Science, Technology, Engineering, and Mathematics Student- Senior High school, Gingoog City Comprehensive National High School, Gingoog City, bjessanto@gmail.com

Fourth author-Canna Regine D. Cubao, Science, Technology, Engineering, and Mathematics Student- Senior High school, Gingoog City Comprehensive National High School, Gingoog City.

Correspondence Author – Hazel R. Balan, msciedhrb@yahoo.com, 09269692358