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# Growth performance of pechay (*Brassica rapa*) in household derived composts

[1]Digno II M. Bercero, [2]Edgardo C. Aranico, [2]Alicia Catalina E. Tabaranza, [2]Ruben F. Amparado Jr.

[1] Regional Agricultural Engineering Division, Department of Agriculture – Regional Field Office 10, Cagayan de Oro City, Philippines; [2] Department of Biological Sciences, College of Sciences and Mathematics, Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines. Corresponding authors: D. II M. Bercero, beerzero2003@gmail.com, and R. F. Amparado Jr., ruben_amparado@yahoo.com

**Abstract**. Vermi worms (*Eisenia fetida*), *Trichoderma harzianum* and Effective Microorganism are organisms commonly used as inoculant in composting which are capable of enhancing compost quality. This study was conducted to assess the growth performance of pechay (*Brassica rapa*) in composts produced from single and combined applications of these organisms applied as mulch. The experiment was laid-out in Randomized Complete Block Design replicated three times. Pechay seedlings were grown in polyethylene bags for four weeks and the number of leaves, width, and length, wet and dry weights were determined. Positive (urea applied at 0.65 grams plant$^{-1}$) and negative (soil only) controls were likewise set-up. Results show that *T. harzianum* + Vermicompost (T4) turned to have superior effects to plant growth as it produced higher number of leaves, widest leaf diameter, highest leaf length and heaviest fresh and dry weights among the six compost treatments and is comparable to plants applied with inorganic fertilizer. Thus, application of compost from *T. harzianum* + Vermi worms can be recommended for pechay production.
**Key Words**: *Brassica rapa*, effective microorganism, *Eisenia fetida*, *Trichoderma harzianum*.

**Introduction**. Every compost activator has a unique outcome in the compost product. Several studies enumerated several positive outcomes in the application of vermi worms (*Eisenia fetida*), *Trichoderma harzianum*, and Effective microorganism (EM) in composting. For instance, vermicompost showed beneficial physical, biological and chemical effects on soils, and these effects increase plant growth and crop yields in both natural and agro ecosystems. Vermicompost have demonstrated consistently beneficial effects on plant growth independent of nutrient transformations and availability (Dominguez et al 2012). Theunissen et al (2010) found that vermicompost contained plants nutrients including N, P, K, Ca, Mg, S, Fe, Mn, Zn, Cu and B, the uptake of which had positive effects on plant nutrition, photosynthesis, chlorophyll content of the leaves and improves the nutrient content of the different plant components (roots, shoots and the fruits). Composting with EM has resulted to an increase in the macro and micronutrient contents of the product (Jusoh et al 2013). Correa (2001) proved that EM compost applied as biofertilizer increased yield of plants such as peanut - *Arachis hypogaea* by 43%, cashew - *Anacardium occidentale* (47.5%), mango - *Mangifera indica* (15%) and guava - *Psidium guajava* (100%). These are some proofs of the beneficial effects acquired from compost products using the selected organisms that are also know to hasten decomposition.

*E. fetida* is one of the top five earthworms used extensively in vermicomposting among the 5,000 species of earthworms. It is one of the first two most commonly used globally for management of organic wastes and in ecotoxicology, physiology and genetics studies (Dominguez et al 2012). This species of earthworm works in mesophilic process during vermicomposting and utilizes microorganisms that are active at 10-32°C pile temperature. The process is faster than composting; because the material passes through their gut, a significant but not yet fully understood transformation takes place, whereby the resulting earthworm casting are rich in microbial activity and plant growth regulators, and fortified with pest repellant attributes as well (Nagavallemma et al 2004).

*T. harzianum* also known as compost fungus activator (CFA), is a single-celled fungus which has been found to be the most promising fungus for fast decomposition of organic matter. This fungus can be found in decaying wood, decaying litters and in forest soil. Compost fungus activator hastens the decomposition process of waste. It shortens the decomposition process to 5-7 weeks instead of four months (Anay et al 1996).

Effective microorganisms are tiny units of life that are too small to be seen with the naked eye and they exist everywhere in nature. Microorganisms are crucial for maintaining the ecological balance. They carry out chemical processes that make it possible for all other organisms including humans to live. It consists of the following five families of micro-organisms: lactic acid bacteria, yeast, actinomycetes, photosynthetic bacteria and fungi (Higa & Parr 1994). EM help to speed up the natural composting process-without many of the negative side-effects of foul odors and pest (Emerald Earth 2013). Compost can be prepared as fast as 3 weeks, compared to a conventional method that last up to 3 months (Correa 2001).

Biofertilizer, a product of composting is a natural alternative to synthetic fertilizers for production. Compost is potentially beneficial to plant growth and is suitable for use as a soil amendment, artificial top soil, growing medium amendment or other similar uses (DEC 2006). Compost acts as a natural fertilizer by providing nutrients to the soil, increasing beneficial soil organisms, and suppressing certain plant diseases, thereby reducing the need for chemical fertilizers and pesticides in landscaping and agricultural activities (USEPA 2002).

The objective of this study was to determine which among the biofertilizer from different compost activators in Phase I experiment which included Vermicompost, *T. harzianum* compost, EM compost, *T. harzianum* + Vermicompost, EM + Vermicompost and *T. harzianum* + EM + Vermicompost have significant effects to plant growth of *Brassica rapa* (pechay) compared to the controls. Comparisons were made by counting the number of leaves and measurement of the leaf width, leaf length, fresh weight and dry weight as suggested by Mrabet et al (2012).

## Material and Method

***Experimental preparation and management.*** This study was conducted in Silver Creek Subdivision, Cagayan de Oro City, Philippines from July 10, 2014 to September 18, 2014 using pechay plant (Figure 1). Pechay seeds were sown in a seed box containing soil media and grown for two weeks (DA-RFU 2000). The seed box was placed in a partly shaded area and watered twice a day (morning and afternoon) (Ramos 2012; AFIS 2009). Seedlings were transplanted individually into polyethylene bags (5” width and 8” height) containing 600 grams of soil and allowed to grow for another four weeks. Thereafter, basal application of 200 grams of compost per plant produced from the different treatments in the Phase 1 experiment was done as modified from Prado (2014). Likewise, 200 grams of soil was added to the positive and negative controls. The positive control was applied with 0.65 grams Urea (46-0-0) as the recommended fertilizer based on soil analysis shown in Table 1. The plants were allowed to grow for another four weeks. The total growing period was 70 days from the seedbed to harvesting (Buan et al 2012).

Table 1

Soil characteristics at Silver Creek Subdivision, Carmen, Cagayan de Oro City

| *Parameter* | *Mean value* |
|---|---|
| pH | 7.63 |
| % OM | 0.9 |
| P (ppm) | 40 |
| K (ppm) | 364 |

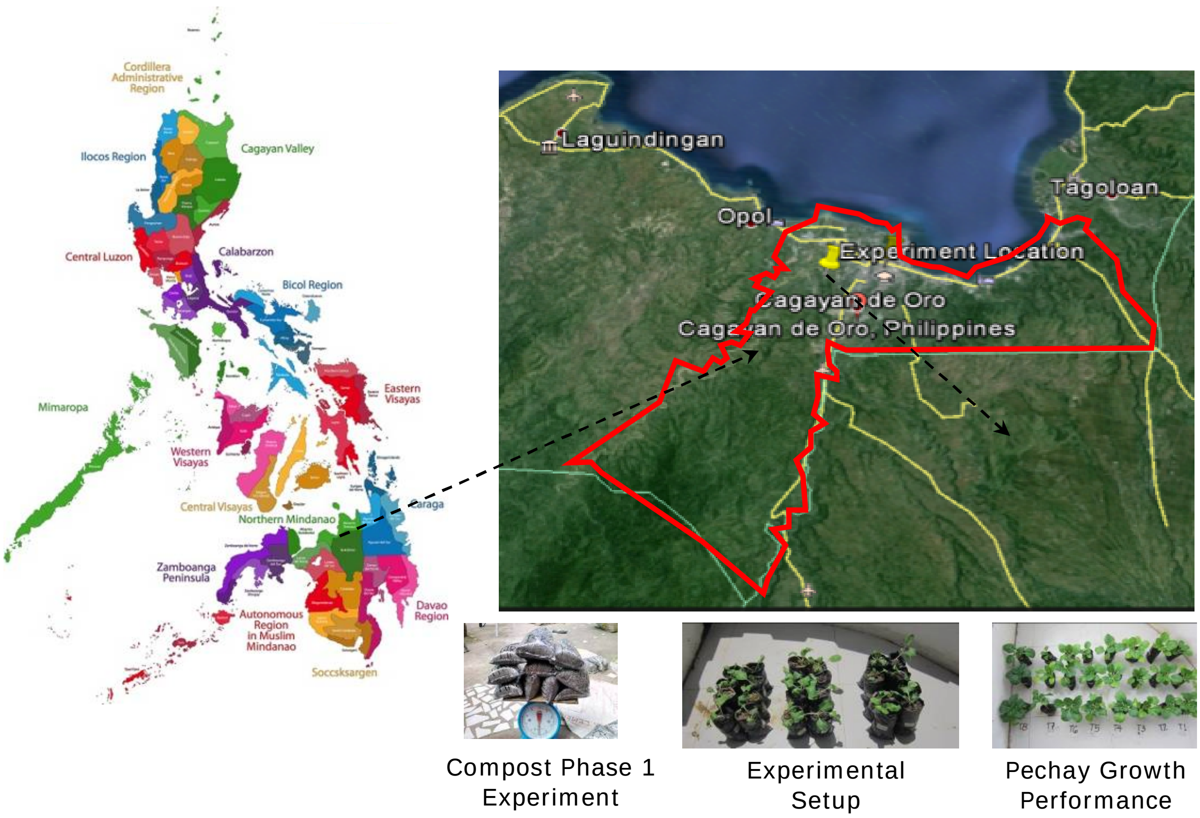


Figure 1. Map of Cagayan de Oro City, Philippines showing the experimental location and a part of the experimental setup (Source: http://thaiembassyuk.org.uk/activities/Philippines-map and Google Earth. Taken: August 24, 2014).

***Experimental design and treatments***. The experiment was laid-out in Randomized Complete Block Design (RCBD) and replicated three times. The treatments used in this study were the products of previous experiment which included following:
1. T1 – Vermicompost;
2. T2 - *T. harzianum* compost;
3. T3 – Effective Microorganism (EM) compost;
4. T4 – *T. harzianum* + Vermicompost;
5. T5 – EM + Vermicompost;
6. T6 - *T. harzianum* + EM + Vermicompost.

The experimental controls were as follows:
7. T7 – plain soil (with no input);
8. T8 – recommended fertilizer based on soil analysis.

***Data collection***. At the end of the growing period, the following parameters were determined and measured: the number of leaves, leaf width, leaf length, fresh and oven dry weights. Number of leaves was determined by direct counting. The width of the leaf was measured at its widest portion. While the length of leaf was measured from the stem (the base of the leaf) to the tip of each leaf. Both were measured using a straight edge ruler in centimeter scale. Fresh weight was measured by weighing air dried uprooted plant in a top loading balance (Mettler PJ400). Uprooting was done by tearing the polyethylene bags and loosening soil to keep roots intact then shaking roots in water to remove the soil. Dry weight was measured by weighing oven dried uprooted plants in a top loading balance. Drying was done by subjecting the plants to 110$^{o}$C temperature in an oven (Memert Oven) for 24 hours. Dried plants were put inside the desiccator to prevent moisture absorption prior to weighing.

***Data analysis***. The results were subjected to the Analysis of Variance (ANOVA) to determine if there are significant differences in the growth performance of pechay seedlings as to the number of leaves, average width and length of leaves, fresh weight of the uprooted plant and oven dry weight of the uprooted plants. Mean separation was applied using the Duncan's Multiple Range Test (DMRT).

**Results and Discussion**. The growth of pechay through basal application of different composts derived from previous experiment was evaluated under Cagayan de Oro City, Philippines condition.

***Effects of different treatments on the number of leaves***. Table 2 shows that among the eight treatments, T1 (vermicompost) posted the highest number of leaves which is significantly different from T7 (control - no input) ($p < 0.05$) but not significantly different from T2, T3, T4, T5, T6 and T8, respectively ($p > 0.05$). It should be noted that all other compost treatments except T1 have no significant difference with the controls (no input) and the recommended fertilizer ($p < 0.05$). This means that vermicompost has the potential in increasing the number of leaves of pechay. This comes in agreement with the result of Edwards et al (2011) on black pepper cuttings grown in vermicompost which posted significantly taller and had more leaves than those grown in commercial potting mixture. Contrary to the findings of this study, Mrabet et al (2012) revealed that household composts applied as soils amendments to lettuce (*Lactuca sativa*) produced significantly higher number of leaves compared to that of the control of 0% compost.

Table 2

Average responses of *Brassica rapa* to household compost under Cagayan de Oro City, Philippines condition

| *Treatment* | [1]*No. of leaves* (pcs)* | [1]*Average leaf width** (cm)* | [1]*Average leaf length* (cm)* | [1]*Fresh weight** (g)* | [1]*Dry weight* (g)* |
|---|---|---|---|---|---|
| T1 | $10.7^{a}$ | $5.17^{abc}$ | $10.7^{ab}$ | $15.4^{bc}$ | $1.23^{ab}$ |
| T2 | $8.3^{ab}$ | $5.65^{ab}$ | $11.3^{a}$ | $16.6^{abc}$ | $1.35^{ab}$ |
| T3 | $10.0^{ab}$ | $5.17^{abc}$ | $10.2^{ab}$ | $15.3^{bc}$ | $1.38^{ab}$ |
| T4 | $9.00^{ab}$ | $6.30^{a}$ | $11.9^{a}$ | $22.5^{ab}$ | $1.89^{a}$ |
| T5 | $10.0^{ab}$ | $4.71^{bc}$ | $8.9^{b}$ | $17.0^{abc}$ | $1.30^{ab}$ |
| T6 | $10.0^{ab}$ | $5.33^{abc}$ | $10.3^{ab}$ | $17.7^{abc}$ | $1.87^{a}$ |
| T7 | $8.0^{b}$ | $4.06^{c}$ | $8.6^{b}$ | $10.28^{c}$ | $0.90^{b}$ |
| T8 | $10.0^{ab}$ | $6.40^{a}$ | $10.6^{ab}$ | $23.5^{a}$ | $1.68^{a}$ |

[1] - Means followed with similar letter are not significantly different from each other; * - Means significant at 5% level of significance; ** - Means significant at 1% level of significance.

***Effects of different treatments on the width of leaves***. Table 2 indicates that the application of T8 and T4 posted the highest values in the average width of leaves and showed significant difference from T5 and T7, respectively ($p < 0.05$). However, the former treatments did not differ significantly from T1, T2, T3 and T6, respectively ($p > 0.05$). This implies that the application of compost derived from T4 is effective in producing wider leaves comparable to inorganic application. However, it was expected that the lowest value came out of the negative control (T7) where no application was done. Similar result was observed by Akanbi et al (2007) that the use of inorganic fertilizer produced the widest leaf in white yam (*Dioscorea rotundata*) but comparable to the use of organic fertilizer. Furthermore, the study of Mrabet et al (2012) showed that in lettuce, wider leaves were produced with the application of compost coming from the combination of *T. harzianum* + Vermicompost which differed significantly from the control ($p < 0.05$).

***Effects of different treatments on the length of leaves***. For the average leaf length, T4 and T2 got the highest (Table 2). They posted significant difference with T7 as the lowest ($p < 0.05$) but not significantly different from T3, T5, T6 and T8, respectively ($p > 0.05$). All applications of compost treatments are comparable to T8. Furthermore, that application of *T. harzianum* as decomposer of wastes in single and combined composting with vermi worms is potential to produce longer leaf length of pechay. This result comes in agreement with the study of Espiritu Bayani (2011) in mungbean (*Vigna radiata*) plant who found out that compost inoculated with beneficial microorganism (*T. harzianum*) at suitable application rate improved significantly the growth of plants in containerized media by producing largest leaf area compared to application of urea. As indicated above, comparison of composts from T4 and T2 with T7 are in accord with the study of Mrabet et al (2012) on lettuce who demonstrated that organic fertilizer application significantly produced longer leaves than the control of 0% compost. Furthermore, Pascual et al (2013) showed that, the leaf length of pechay was significantly longer with the application of organic fertilizer than with no fertilizer and inorganic fertilizer.

***Effects of different treatments on the fresh weight.*** Results show that plants applied with T8 posted the highest fresh weight but not significantly different from T2, T4, T5 and T6, respectively ($p > 0.05$) but showed significant difference from plants in the negative control, plants applied with T3 and T1 ($p < 0.05$). This could be due to the fact that nutrients in chemical fertilizers are readily soluble and immediately available to the plants, hence, their effects are usually direct and fast (Chen 2006). However, Pascual et al (2013) showed evidence in their study that application of organic fertilizer to pechay produced significantly higher fresh weight of shoot and roots compared to no fertilizer and application of inorganic fertilizer. Furthermore, Mrabet et al (2012) supported the above outcome that the application of organic fertilizer on lettuce significantly produced heavier fresh weight of the leaves and roots than the control of 0% compost.

***Effects of different treatments on the dry weight.*** Results show that T4 has the highest dry weight and elicited significant difference from T7 ($p < 0.05$) but not significantly different from T1, T2 T3, T5, T6 and T8, respectively ($p > 0.05$). This indicates that the application of T4 results to heavier dry mass in the growth of plants and exceeded synthetic fertilizer application. This result is similar to the study of Lopez et al (2014) on the growth and yield of pechay found that the combination of two *Trichoderma* species in composting, which have the potential use as bio-fertilizer, increased its growth compared to single species application alone. Furthermore, Prado (2013) showed similar result, that pechay when applied with organic inputs for its growth has comparative advantage over that of the farmers' practice of using urea although not statistically different from each other ($p > 0.05$). This implies the use of organic inputs as an alternative to chemical fertilization. Pascual et al (2013) further demonstrated that organic fertilizer produced significantly higher dry weights of shoots and roots of pechay compared to no fertilizer and application of inorganic fertilizer. Mrabet et al (2012) showed similar result where application of organic fertilizer on lettuce significantly produced heavier dry weight of the leaf and roots than the control of 0% compost.

**Conclusions**. Based on the results of the study, application of *T. harzianum* + *E. fetida* compost produced comparable results as to the number of leaves, leaf width, leaf length, fresh weight and dry weight with the positive control (inorganic fertilizer (Urea) at 0.65 grams $plant^{-1}$) indicating that it is a good alternative to application of inorganic fertilizer to the growth of pechay. Compost derived from the application of *T. harzianum* + Vermi worms (T4) is highly recommended for the production of pechay.

This study further supports the need to use organic fertilizer as a healthy alternative to inorganic fertilizer application. Besides, composting being a natural aerobic process readily converts wastes into nutrient laden biofertilizer which can also be used as soil ameliorant. This practice reduces the impact of climate change and favors the production of vegetables in containerized plant growing in an urban setting where space is a limitation.

It is recommended to study the economics of using this compost and test it to other vegetable crops.

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## References

Agriculture and Fisheries Information Service (AFIS), 2009 Green leafy vegetables. Department of Agriculture, Elliptical Road, Diliman, Quezon City 1100. Retrieved September 30, 2014, at: http://www.trc.dost.gov.ph/trcfile/Technology-Snapshots/Farming-Tips/green leafyvegetables.pdf.

Akanbi W. B., Olaniran O. A., Olaniyan A. B., 2007 Effect of integrated use of organic and inorganic nutrient sources on growth and tuber characteristics of white yam (*Dioscorea rotundata*) cv ehuru. African Crop Science Conference Proceedings 8:359-363.

Anay R. E., Rejas R. T., Caday E. C., 1996 The performance of compost fungus activator on different compost substrate. Northern Mindanao Agricultural Research Center (NOMIARC) Research Compendium C.Y., pp. 1-7.

Buan R. P., Po R. A., Dimaculangan M. M., Ibero J. B., Jara M. F., Baranda E. J., 2012 The effect of "Hugas-Bigas" on the growth of pechay (*Brassica pekinensis*) plants. Retrieved October 1, 2014, at: http://www.edu-sciece.com/2012/11/the-effect-of-hugas-bigas-on-growth-of.html.

Chen J. H., 2006 The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility. International Workshop on Sustained Management of the Soil-Rhizosphere System for Efficient Crop Production and Fertilizer Use. Land Development Department, Bangkok 10900 Thailand, 16-20 October, pp. 1-11.

Correa M., 2001 The impact of effective microorganisms (EM) in various farming systems. International Workshop on E.M. Technology Programme. Asian Pacific Nature Agriculture Network, Saraburi, Thailand 21-24 February 2001.

Department of Agriculture – Regional Field Unit 4-B (DA-RFU 4-B), 2000 Pechay Production Guide. PCARRD. MiMaRoPa Info Bulletin #161/2000 retrieved October, 2013 at http://www.darfu4b.da.gov.ph/pechay.html.

Department of Environment and Conservation (DEC), Tennessee, 2006 Solid waste processing and disposal. Rules of Tennessee Department of Environment and Conservation, Division of Solid Waste Management, Chapter 1200-1-7, pp. 1-130.

Dominguez J., Aira M., 2012 Twenty years of the earthworm biotechnology research program at the University of Vigo, Spain. International Journal of Environmental Science and Engineering Research 3(2):1-7.

Edwards C. A., Arancon N. Q., Sherman R. L., 2011 Vermiculture technology: earthworms, organic wastes, and environmental. CRC press, Taylor and Francis group, 6000 Brokensound Parkway NW. ISBN 978-1-4398-0987-7. pp 1-587.

Emerald Earth, 2013 Composting with effective microorganisms. Retrieved October, 2013 at: http://www.emearth.com/PDFs/EMComposting.pdf.

Espiritu Bayani M., 2011 Use of compost with microbial inoculation in container media for mungbean (*Vigna radiata* L. Wilckzek) and pechay (*Brassica napus* L.). J ISSAAS 17(1):160-168.

Higa T., Parr J. F., 1994 Beneficial and effective microorganisms for a sustainable agriculture and environment. International Nature Farming Research Center, Atami, Japan, pp. 1-21.

Jusoh M. L., Manaf L. A., Latiff P. A., 2013 Composting of rice straw with effective microorganism (EM) and its influence on composting quantity. Iranian Journal of Environmental Health Science & Engineering 10:17.

Lopez L. L. M. A., Aganon C. P., Juico P. P., 2014 Isolation of *Trichoderma* species from carabao manure and evaluation of its beneficial uses. International Journal Of Scientific & Technology Research 3(8):190-199.

Mrabet L., Belghyti D., Loukili A., Attarassi B., 2012 Effect of household waste compost on the productivity of maize and lettuce. Agricultural Science Research Journals 2(8):462-469.
Nagavallemma K. P., Wani S. P., Lacroix S., Padmaja V. V., Vineela C., Babu Rao M., Sahrawat K. L., 2004 Vermicomposting: recycling waste into valuable organic fertilizer. Global Theme on Agriecosystems Report No. 8. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. Volume 2, Issue 1, 20 pp.
Pascual P. R. L., Jarwar A. D., Nitural P. S., 2013 Fertilizer, fermented activators, and EM utilization in pechay (*Brassica pekinensis* L.) production. Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Sciences 29(1):56-69.
Prado A. J., 2014 Effect of organic fertilizer on the growth performance of *Brassica rapa* under La Union, Philippines. E-International Scientific Research Journal 5(4):1-6.
Ramos-Aquino M., 2012 Urban farmer: pechay by golly, wow! Home and Garden. Retrieved on September 30, 2014, at: http://www.interaksyon.com/lifestyle/urban-farmer-pechay-by-golly-wow.
Theunissen J., Ndakidemi P. A., Laubscher C. P., 2010 Potential of vermicompost produced from plant waste on the growth and nutrient status in vegetable production. International Journal of the Physical Sciences 5(13):1964-1973.
U.S. Environmental Protection Agency (USEPA), 2002 Solid waste management and climate change. Solid Waste and Emergency Response. Retrieved August 2014, at: www.epa.gov/globalwarming.
*** http://thaiembassyuk.org.uk/activities/Philippines-map.

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Authors:
Digno II M. Bercero, Regional Agricultural Engineering Division, Department of Agriculture – Regional Field Office 10, Cagayan de Oro City, Philippines, e-mail: beerzero2003@gmail.com
Edgardo C. Aranico, Department of Biological Sciences, College of Sciences and Mathematics, Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines, e-mail: ecardbs_csmmsuiit@yahoo.com
Alicia Catalina E. Tabaranza, Department of Biological Sciences, College of Sciences and Mathematics, Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines, e-mail: acetabaranza@yahoo.com
Ruben F. Amparado Jr., Department of Biological Sciences, College of Sciences and Mathematics, Mindanao State University – Iligan Institute of Technology, Iligan City, Philippines, e-mail: ruben_amparado@yahoo.com

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