European Journal of Agricultural and Rural Education (EJARE)
Available Online at: https://www.scholarzest.com
Vol. 3 No. 4, April 2022
ISSN: 2660-5643

GROWTH AND YIELD PERFORMANCE OF RADISH AS AFFECTED BY DIFFERENT AMOUNT OF EM-BOKASHI IN LAHAR SOIL

Ronel S. De Guzman* and Jamil R. Dagupan
President Ramon Magsaysay State University, Zambales, Philippines, 2207
neldaghostman06@prmsu.edu.ph*

Article history:

Received: 1st February 2022
Accepted: 28th February 2022
Published: 18th April 2022

Abstract:

The study aimed to evaluate the effects of the different amount of EM-bokashi in the performance of radish (*Raphanus sativus*) planted in potted lahar soil in an open field. It specifically evaluated the effects of EM-bokashi on the growth and yield parameters of radish. It consisted of four treatments and three replications in a Randomized Complete Block Design (RCBD). The treatments were the following: Treatment 1 (no application), Treatment 2 (100g), Treatment 3 (200 g), and Treatment 4 (300g) per pot measuring 10x10x17 inches. Based on the result of the study, Treatment 4 showed a significant difference among the treatments in terms of the average tuber diameter. Also, it showed a highly significant difference in the average number of days to germination, final length of the longest leaf, average tuber length, and average tuber weight. It is further supported by LSD as it showed significant differences in control and among other treatments.

Therefore, the application of 300g of EM-bokashi is recommended for radish production.

Meanwhile, the researchable areas to be addressed, are the evaluation of higher rates of EM-bokashi due to increasing trends in all parameters, conduct of field testing, assessment of residual effect, combination with other organic fertilizers, and continuous utilization in other crops, particularly long-duration crops, to evaluate its effect further.

Keywords: EM-bokashi, lahar soil, organic, pot, radish

INTRODUCTION

Rationale

Radish (*Raphanus sativus*) is one of the primary vegetable crops in the Philippines. Consumers highly praise it for its peppery taste. It could be consumed raw in salads, made as pickles, or cooked with fish, meat, shrimp, and other dishes (Bureau of Plant Industry, 2016).

According to Reyes and Neue (1991), the lahar can support various crops when the appropriate cultural and management inputs are used. Carbon and nitrogen are almost non-existent in the volcanic material. Although it contains an adequate amount of phosphorus, it is not readily available. While the solubility of cautions is moderate, the ability to keep and exchange warnings is limited. Sulfate concentrations are within the usual range. Although the more recent volcanic eject is acidic, the pH is around neutral to alkaline. Lahars are also more acidic.

Conventional agriculture is heavily reliant on chemical fertilizers, which has resulted in problems with human health and environmental degradation, motivating researchers to develop chemical fertilizer alternatives (Chen, 2006). According to Moller (2009) organic fertilizers have enormous potential as a source of numerous nutrients and as a means of improving soil properties when used effectively and widely. Currently, the utilization of wood vinegar or mokosaku was tested for seed germination, pest management and production of fruits and vegetables (Garcia-Perez et al., 2007; Nakai et al., 2007; Masaki, 2011; Zulkarami et al., 2011; Ho et al., 2013; De Guzman & Adalla, 2021; De Guzman & Cababaro; 2021; De Guzman & Dadural, 2021).

Bokashi is a term used in Japan to refer to fermented organic materials (Boechat et al., 2013). This soil amendment is made up of an organic waste substrate and Effective Microorganisms (EM), a commercially accessible solution of naturally occurring soil microbes with beneficial properties. It is fermented prior to use (Boechat et al., 2013; Mayer et al., 2008; Ndona et al., 2011). Due to the microbial makeup of EM, the fermentation process is predominantly lactic. It can be carried out anaerobically in closed vessels or aerobically, much like traditional composting, but with the option of using a thin cover such as a jute bag (Boechat et al., 2013).

EM is composed of five major types of aerobic and anaerobic microbes: photosynthetic bacteria (*Rhodopseudomonas palustrus, Rhodobacter spaeroides*), lactic acid bacteria (*Lactobacillus plantarum, Lactobacillus casei, Streptococcus*

lactis), yeasts (*Saccharomyces cerevisiae, Candida utilis*), actinobacteria (*Streptomyces albus, S. griseus*), and fermentative fungi (*Aspergillus oryzae, Mucor hiemalis*) (Ndona et al., 2011; Fatunbi & Ncube, 2009). According to Analisis molecular (2014) laboratory analysis of the particular bokashi product confirmed the presence of numerous additional bacterial groups, including *Nitrosomonas multiformis*, which fixes nitrogen into plant-available forms, *Trichoderma spp., Bacillus spp.,* and *Streptomices spp.*, all of which are beneficial in the fight against pests.

According to Ishimura (2004), the bokashi possess several favorable characteristics on the agriculture, once afford rapid nutrients release, assists on soil physics aspects, as its structure maintenance, besides also support in some diseases and pest's prevention and control, once it has a microorganism's broad range, introduced with the EM utilization, prepared from organism's virgin forest collected.

Bokashi and EM are said to promote soil fertility, crop output, plant nutrition, insect and disease management, and soil physical qualities (Golec et al., 2007; Mayer et al., 2008; Pineda et al., 2010).

Thus, the study was conducted to evaluate the effect of different amounts of EM-bokashi in the growth and yield performance of radish in lahar soil.

OBJECTIVE OF THE STUDY

Generally, the study aims to evaluate the growth and yield performance of radish in lahar soil as affected by different amount of EM-bokashi application. Specifically, it aims to: determine the effects of EM-bokashi application in growth performance of radish; evaluate the effects of EM-bokashi application in yield performance of radish; and recommend the best amount of EM-bokashi to be used in radish production in lahar soil.

METHODOLOGY

Experimental Treatments and Design

The study used a Randomized Complete Block Design (RCBD) with four (4) distinct treatments, three (3) replicates, and ten (10) sample plants per replication. One hundred twenty (120) sample plants were used.

The treatments are as follows:

Treatment 1- Control/No application
Treatment 2- 100g EM-Bokashi /pot
Treatment 3-200g EM- Bokashi/pot
Treatment 4-300g EM-Bokashi/pot

MATERIALS

The materials used in this study were radish seeds, lahar soil, polyethylene bags, a record notebook with ball pen, digital weighing scale, tape measure, caliper, and EM-bokashi.

Preparation of EM-bokashi

In the initial preparation of the EM-bokashi, the Indigenous Microorganism (IMO) was diluted with molasses in water (300 ml of IMO + 30 liters of water). Then, solid ingredients (20 kg rice bran, 20 kg carbonized rice hull, and 20 kg chicken manure) were prepared and mixed with water and 30 liters of diluted IMO solution at 30-40% moisture content. After mixing the ingredients, cover it with sacks and ferment it for two (2) weeks in a covered area without rain or direct sunlight. During fermentation, gradually remix the mixture if its temperature exceeds 50^{o}C and cover. If the temperature is stable and has a sweet-sour fermented smell, the EM-bokashi is ready for use. This method was based on the research of Alvior (2018).

Potting

Lahar soil was placed in 10x10x17 polyethylene bags up to 1 inch from the brim of the plastic before planting.

Water Management

Watering of plants was done every day with 1.75 liters of water, filling it up to the brim of the polyethylene plastic bag. Excessive water will cause the seed to decay, while insufficient water will cause the germination process to fail.

Fertilizer Management

EM-bokashi was mixed in the soil based on the treatment before planting.

Harvesting

The radish was harvested on 32 days from seed sowing.

DATA GATHERED

Average Number of Days to Germination

The number of days required for germination as manually counted from seed sowing.

Final length of longest leaf (mm)

On 32 days after seed sowing, the length of the longest leaf was measured.

Average Tuber Length(cm)

The tuber's length was determined in centimeters using a tape measure (cm).

Average Tuber Diameter(mm)

A caliper was used to determine the diameter of the tuber.

Average Tuber Weight (g)

The weight of the tuber was weighed using a digital weighing scale in grams (g).

STATISTICAL ANALYSIS

Significant differences will be evaluated using Analysis of Variance (ANOVA) using Randomized Complete Block Design (RCBD). Differences among treatment means will be determined using Least Significant Differences (LSD) at 5% at level of significance.

RESULTS AND DISCUSSION

In this study, the effects of the different amounts of EM-bokashi in radish were evaluated.

Average Number of Days to Germination

Table 1 presents the average number of days to germination.

Table 1. Average number of days to germination

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	5.9	5	4.9	15.8	5.27^{c}
Treatment 2 (100g)	5.6	4.7	4.8	15.1	5.03^{bc}
Treatment 3 (200g)	4.8	4.4	4.5	13.7	4.55^{ab}
Treatment 4 (300g)	4.3	4.2	4.2	12.7	4.23^{a}

**Highly significant
CV= 5.00%
LSD 5%=0.4768

Table 1 showed that plants applied with Treatment 4 have the fastest growth with an average 4.23 days, followed by Treatment 3, Treatment 2 and Treatment 1 with averages of 4.55 days, 5.03 days and 5.27 days respectively.

The ANOVA revealed that there was a high significant difference in amounts of EM-bokashi because the computed F value of 11.33 and was higher than 5%and 1% of significance. Furthermore, LSD showed that there are significant differences between treatments.

Roldi et al. (2013) confirmed this finding, stating that using bokashi ensures the healthy development of bacterial pedoflora and soil nutrients, prevents salinization and pollution of groundwater, protects crops from pathogen attack, and provides nutrients (such as amino acids) that are easily assimilated by plant roots. This promotes radish seed germination.

Final Length of the Longest Leaf

Table 2 presents the final length of the longest leaf.

Table 2. Average final length of the longest leaf.

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	49.5	51.6	64.6	165.70	55.23^{d}
Treatment 2 (100g)	54.9	67.1	70.6	192.60	64.20^{c}
Treatment 3 (200g)	66.7	80.6	86.8	234.10	78.03^{b}
Treatment 4 (300g)	76.3	84.7	93.6	254.60	84.87^{a}

**Highly significant
CV= 4.04%
LSD 5%= 5.6974

As shown in Table 2, the plants applied with Treatment 4 produced the tallest plants among all treatments with an average of 84.87 mm, followed by Treatment 3, Treatment 2 and Treatment 1 with averages of 78.03 mm, 64.2 mm and 55.23 mm respectively.

The ANOVA revealed that there was a high significant difference in amounts of EM-bokashi because the computed F value of 65.90 and was higher than 5% and 1% of significance. Furthermore, LSD showed that there are significant differences between treatments.

Goulart et al. (2018) confirmed this finding, indicating that bokashi surpasses traditional organic fertilizers in terms of leaf production, plant biomass, and nutrient availability. Additionally, the addition of bokashi increased the quantity of beneficial microorganisms in the substrate, which may have accelerated nutrient cycling and availability; additionally, because bokashi contains nitrogen fixers, nitrogen and other nutrients were made more available (Ivares-Sols et al., 2016).

Average Tuber Length(cm)

Table 3 presents the average tuber length (cm).

Table 3. Average tuber length (cm)

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	7.18	7.22	8.39	22.79	7.60[c]
Treatment 2 (100g)	8.37	8.59	9.3	26.26	8.75[b]
Treatment 3 (200g)	10.1	9.35	9.23	28.68	9.56[b]
Treatment 4 (300g)	10.6	10.3	10.8	31.70	10.57[a]

**Highly significant
CV= 5.16%
LSD 5%= 0.9410

Table 3 showed that plants applied with Treatment 4 produced the longest tuber with an average of 10.57 cm, followed by plants applied with Treatment 3, Treatment 2 and Treatment 1 with averages of 9.56 cm, 8.75 cm and 7.60 cm respectively.

The ANOVA revealed that there was a high significant difference in amounts of EM-bokashi because the computed F value of 21.38 and was higher than 5% and 1% of significance. Furthermore, LSD showed that there are significant differences between treatments.

According to Xu et al. (2000), the microbial component of bokashi is crucial for water and mineral absorption, biocontrol, and plant biostimulation activities in the rhizosphere. Additionally, Ginting (2019) stated that using Bokashi increases soil fertility, which results in increased plant nutrient uptake.

Average Tuber Diameter (mm)

Table 4 presents the average tuber diameter (mm).

Table 4. Average tuber diameter (mm)

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	24.9	24.2	23.4	72.50	24.17
Treatment 2 (100g)	30.7	25	26.2	81.90	27.30
Treatment 3 (200g)	31.9	30.3	21.3	83.50	27.83
Treatment 4 (300g)	32.7	33.3	31.4	97.40	32.47

*Significant
CV= 9.90%

Table 4 showed that Treatment 4 plants has the biggest tuber diameter as with an average of 32.4 cm, followed by plants applied with Treatment 3, Treatment 2 and Treatment 1 with averages of 30.5 cm, 27.3 cm and 24.1 cm respectively.

The ANOVA revealed that there was a significant difference in amounts of EM-bokashi because the computed F value of 4.59 and was higher than 5% of significance. The LSD showed that there are no significant differences between treatments.

Hata et al. (2021) confirmed the result, stating that bokashi treatment enhanced tomato fruit diameter. The bigger stem diameters found in plants growing in the substrates, both with bokashi, allowed for greater root development, which decreased the time required to transplant seedlings into the field (Campos & Uchida, 2002). Additionally, Hata et al. (2019) reported that EM-bokashi has been tested on radish with good results.

Average Tuber Weight (g)

Table 5 presents the average tuber weight (g).

Table 5. Average tuber weight (g)

Treatment	R1	R2	R3	Total	Mean
Treatment 1 (control)	20	25.6	25.3	70.90	23.63[c]
Treatment 2 (100g)	36.5	25.9	35.1	97.50	32.50[c]
Treatment 3 (200g)	53.9	50.3	51.5	155.70	51.90[b]
Treatment 4 (300g)	84.4	82.6	59.1	226.10	75.37[a]

**Highly significant
CV= 18.25%
LSD 5%=16.7202

As shown in Table 5, the plants applied with Treatment 4 plants produced the heaviest fruit with an average of 75.3 grams, followed by plants applied with Treatment 3, Treatment 2 and Treatment 1 with averages of 52 grams, 32.5 cm and 23.6 grams respectively.

The ANOVA revealed that there was a high significant difference in amounts of EM-bokashi because the computed F value of 22.55and was higher than 5% and 1% of significance. Furthermore, LSD showed that there are significant differences between treatments.

Mbouobda et al. (2014) confirmed this finding, stating that EM-bokashi resulted in much higher tuber weights when compared to other organic fertilizers. Additionally, Hata et al. (2019) reported that EM-bokashi has been tested on radish with good results.

CONCLUSION AND RECOMMENDATION

This study was an evaluation of EM-bokashi in the growth and yield performance of radish in lahar soil. With the results, it was concluded that Treatment 4 (300g of EM-bokashi) performed highly significant than the other treatments. The result of study in the average of tuber diameter showed significant differences among treatments. Also, the number of days to germination, final length of the longest leaf, average of tuber length, and average of tuber weight showed highly significant differences among the treatments.

Therefore, the application of Treatment 4 (300g) is the highly recommended amount in radish.

Hence, there are researchable areas to be addressed, such as the evaluation of higher rates of EM-bokashi due to increasing trends in all parameters, conduct of field testing, assessment of residual effect, combination with other organic fertilizers, and continuous utilization in other crops, particularly long-duration crops, to evaluate its effect further.

REFERENCES

1. Alvior, N. A. E. (2018). The response of lettuce (*Lactuca sativa* l.) to the application of bokashi with different kinds of animal manure [Unpublished Thesis]. *Ramon Magsaysay Technological University*. pp 10.
2. Álvarez-Solís, J. D., Mendoza-Núñez, J. A., León-Martínez, N. S., Castellanos-Albores, J., & Gutiérrez-Miceli, F. A. (2016). Effect of bokashi and vermicompost leachate on yield and quality of pepper (*Capsicum annuum*) and onion (*Allium cepa*) under monoculture and intercropping cultures. International Journal of Agriculture and Natural Resources, 43(2), 243-252. https://doi.org/10.4067/S0718-16202016000200007
3. Análisis molecular. (2014). A. D. N. R. C. Agrosupplies, S. A.: Dolega, Chiriquí, Panamá.
4. Boechat, C. L., Santos, J. A. G., & Accioly, A. M. D. A. (2013). Net mineralization nitrogen and soil chemical changes with application of organic wastes with 'Fermented bokashi compost'. *Acta Scientiarum. Agronomy*, 35, 257-264. https://doi.org/10.4025/actasciagron.v3512.14133.
5. Bureau of Plant Industry. (2016). Radish seed production guide. http://bpi.da.gov.ph/bpi/images/Production_guide/pdf/RADISH%20SEED%20PRODUCTION.pdf
6. Campos, M. A. A., & Uchida, T. (2002). Influence of shading on the growth of seedlings of three Amazonian species. *Pesquisa Agropecuária Brasileira,* 37(3): 281-288. https://doi.org/10.1590/S0100-204X2002000300008
7. Chen, J. H. (2006, October). The combined use of chemical and organic fertilizers and/or biofertilizer for crop growth and soil fertility. In International workshop on sustained management of the soil-rhizosphere system for efficient crop production and fertilizer. *Land Development Department Bangkok Thailand*. 16(20):1-11.
8. De Guzman, R. S. & Adalla, J. A. (2021). Growth of first three seedlings from polyembryonic mango seed applied with wood vinegar. *European Journal of Agricultural and Rural Education*, 2(4), 14-32. http://doi.org/10.5281/zenodo.4764676

9. De Guzman, R. S. & Cababaro, A. C. (2021). Utilization of wood vinegar as nutrient availability enhancer in eggplant (*Solanum melongena* L.). *International Journal of Multidisciplinary: Applied Business and Education Research*. 2(6), 485– 492. http://doi.org/10.11594/ijmaber.02.06.04
10. De Guzman, R. S. & Dadural, M. I. Y. (2021). Seed germination and seedling growth of mango as affected by different concentrations of wood vinegar. *Galaxy International Interdisciplinary Research Journal (GIIRJ)*, 9(5), 49–60. http://doi.org/10.5281/zenodo.4764690
11. Fatunbi, A. O., & Ncube, L. (2009). Activities of effective microorganism (EM) on the nutrient dynamics of different organic materials applied to soil. *American-Eurasian Journal of Agronomy*, 2(1), 26-35.
12. Garcia-Perez M., Chaala, A., & Pakdel, H. (2007). Production and fuel properties of pine chip bio-oil/bio-diesel blends. *Journal Analytical and Applied Pyrolysis,* 78(1): 104-116.
13. Ginting, S. (2019). Promoting Bokashi as an organic fertilizer in Indonesia: A mini review. *International Journal of Environmental Science and Natural Resources,* 21, 556070. https://doi.org/10.19080/IJESNR.2019.21.556070
14. Golec, A. F. C., Pérez, P. G., & Lokare, C. (2007). Effective microorganisms: myth or reality? *Revista Peruana de Biología,* 14(2), 315-319. http://doi.org/10.15381/rpb.v14i2.1837
15. Goulart, R. G. T., dos Santos, C. A., de Oliveira, C. M., Costa, E. S. P., de Oliveira, F. A., de Andrade, N. F., & do Carmo, M. G. F. (2018). Agronomic performance of lettuce cultivars under organic fertilization in Seropédica, RJ. *Revista Brasileira de Agropecuária Sustentável*, *8*(3), 66-72.
16. Hata, F. T., Sousa, V., & Fregonezi, G. A. D. F. (2019). Low-cost organic fertilizations and bioactivator for arugula-radish intercropping. *Emirates Journal of Food and Agriculture*, 773-778.
17. Hata, F. T., Ventura, M. U., Fregonezi, G. A. D. F., & Lima, R. F. D. (2021). Bokashi, boiled manure and penergetic applications increased agronomic production variables and may enhance powdery mildew severity of organic tomato plants. *Horticulturae*, 7(2), 27. https://doi.org/10.3390/horticulturae7020027
18. Ho, C. L., Lin, C. Y., Ka, S. M., Chen, A., Tasi, Y. L., Liu, M. L., Chiu, Y. C., & Hua, K. F. (2013). Bamboo vinegar decreases inflammatory mediator expression and NLRP3 inflammasome activation by inhibiting reactive oxygen species generation and protein kinase C-α/δ activation. *PloS One* 8(10): 1-11.
19. Masaki Y. (2011). Farmers in Benguet Practice Savers Technology. *Safe Vegetable Promotion Project in Benguet.* Department of Agriculture and Japan International Cooperation.
20. Mayer, J., Scheid, S., & Oberholzer, H. R. (2008). How effective are 'Effective Microorganisms'? Results from an organic farming field experiment.
21. Mbouobda, H. D., Fotso, Djeuani, C. A., Baliga, M. O., & Omokolo, D. N. (2014). Comparative evaluation of enzyme activities and phenol content of Irish potato (*Solanum tuberosum*) grown under EM and IMO manures Bokashi. *International Journal of Biological and Chemical Sciences,* 8(1): 157-166. http://dx.doi.org/10.4314/ijbcs.v8i1.15
22. Moller, K. (2009). Influence of different manuring systems with and without biogas digestion on soil organic matter and nitrogen inputs, flows and budgets in organic cropping systems. *Nutr Cycl Agroecosyst* 84: 179-202. https://doi.org/10.1007/s10705-008-9236-5
23. Nakai, T., Kartel, S. N., Hata, T., and Imamura, Y. (2007). Chemical characterization of pyrolysis liquids of wood-based composites and evaluation of their bio efficiency. *Building and Environment*. 42, 1236-1241.
24. Ndona, R. K., Friedel, J. K., Spornberger, A., Rinnofner, T., & Jezik, K. (2011). 'Effective micro-organisms'(EM): an effective plant strengthening agent for tomatoes in protected cultivation. *Biological Agriculture & Horticulture*, 27(2), 189-203.
25. Pineda, A., Zheng, S. J., van Loon, J. J., Pieterse, C. M., & Dicke, M. (2010). Helping plants to deal with insects: the role of beneficial soil-borne microbes. Trends in plant science, 15(9), 507-514. http://doi.org/10.1016/j.tplants.2010.05.007
26. Reyes R. Y. & Neue, H. U. (1991). Characterization of the Volcanic Ejecta from Mount Pinatubo and Its Impact on Rice Production. Philippine Journal Crop Science 1991. 16(2) 69-73.
27. Roldi, M., Dias-Arieira, C.R., Severino, J. J., Santana, S. D. M., Dadazio, T. S., Marini, P. M., Mattei D. (2013). use of organic amendments to control *Meloidogyne incognita* in tomatoes. *Nematropica*, 43(1), 49-55.
28. Zulkarami, B., Ashrafuzzaman, M., Husni M. O., and Is-mail1, M. R. (2011). Effect of pyroligneous acid on growth, yield and quality improvement of rockmelon in soilless culture. *Australian Journal of Crop Science*, 5(12): pp. 1508-1514.