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Research Article

Response of growth performance and yield of butternut squash (*Cucurbita moschata* Duch Ex Poir) cultivar Waltham under different dosages of bokashi application

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Abstract
Butternut squash, also known as *Cucurbita moschata*, is a variety of pumpkin with promising commercial potential. However, most of the soils in the tropics are acidic and lack organic matter.The addition of organic material such as bokashi is essential in improving the low soil pH and soil quality. Therefore, this study aimed to elucidate the effects of different rates of bokashi application on the growth performance and yield of butternut squash cultivated on tropical acid soil. A planting experiment was carried out from July until October 2022. A total of 36 planting beds were prepared, and each bed was constructed in 100 cm x 400 cm, consisting of 8 plants bed^{-1}. The experiment was arranged in a Randomized Complete Block design. A total of three different rates of bokashi were applied to the soil prior to planting, namely 0 (control), 4,000, and 8,000 kg ha^{-1}. A 12,000 kg ha^{-1} of commercial peat moss (Holland Free Peat) was also applied to compare bokashi and peat moss (the common planting medium used in most planting activities). The maximum plant height growth and leaf production for butternut squash was around 7-8th week. Application rate of 8,000 kg ha^{-1} bokashi contributed to significantly highest plant height (352.1 cm), number of leaves (86 leaves), and yield of Waltham butter squash per plant (1.5 kg plant^{-1}). Multiple planting cycles should be carried out further to elucidate the bokashi's residual effect on nutrient supply to butternut squash cultivation.

Keywords: Bokashi, Organic matter, Waltham butternut squash, Yield production

INTRODUCTION

Butternut squash, also known as *Cucurbita moschata*, is a variety of pumpkin that belongs to a group of horticultural annual plants with promising commercial potential. Butternut squash has recently gained popularity in Indonesia since 2013 (Baldotto and Baldotto, 2016).The fruit resembles a nut in shape and is particularly well-liked in Indonesia (Kurniati *et al.,* 2018). Butternut squash can be used to make juice, jam, and baby food in addition to being eaten raw.Additionally, it can be utilized as a cake and spaghetti colour (Paulauskiene *et al.,* 2018). As long as there is consistent, adequate rainfall throughout the year, this plant may thrive in Indonesia's tropical climate.The success of a plant to grow and produce well is determined not only by genetic and environmental factors but also by the way soil and crops are managed, such as by adding nutrients through fertilization (Melo *et al.,* 2013).Since the climatic conditions in Indonesia and Malaysia are similar and close to the equator, Malaysia is expected to produce a significantly high yield of butternut squash similar to that in Indonesia.

Acidic soils make up one-third of the global soils. The tropics, particularly Malaysia, are where about half of them are found. Soil acidity is one of the top five global constraints on boosting agricultural output. Aluminium (Al), manganese (Mn), and iron (Fe) toxicities, as well as shortages in macro and micronutrients, are characteristics of highly weathered tropical acid soils (Hamidi et al., 2021). Most of the acidic soils in the tropics, such as Ultisols and Oxisols lack organic matter, which can supply plant nutrients and improve the structure of mineralised soils (Paramisparam *et al.,* 2021).

The use of organic fertilizers can bind easily lost nutrients and help replenish soil nutrients, increasing fertilizer efficiency, which is why adding organic material is so beneficial for restoring deteriorated soil. Compost is the organic matter usually applied for alleviating the infertility of Ultisols and Oxisols (Anda *et al.,* 2010). Composting, however, poses difficulties for farmers because it requires infrastructure, specialized equipment, and a variety of factors to meet quality standards (Christel, 2017).

There are compost substitutes that have not been as thoroughly studied in agricultural settings. One of these is bokashi, which uses several formulas and an inoculum of bacteria to degrade organic materials (Christel, 2017). According to Krimuna *et al.* (2016) and Zaman *et al.* (2016), it is regarded as an organic fertilizer that can bolster crops, boost plant development and production, and enhance soil structure and water retention. According to the research, bokashi positively impacts crop output and soil fertility (Dou *et al.,* 2012). According to Ferreira *et al.* (2016), applying bokashi enhanced lettuce's vegetative growth and nematode control. According to Christel (2017), bokashi boosted the height and biomass of spinach when grown in a greenhouse. However, the utilization of bokashi in the growth of butternut squash has not been thoroughly investigated. Therefore, this study aimed to elucidate the effects of various bokashi application rates on the development characteristics and yield of butternut squash (*Cucurbita moschata*) grown in tropical acid soil.

MATERIALS AND METHODS

Initial soil sampling

Before the commencement of the planting experiment, the soil samples were collected systematically from the planting experiment site of Agro Techno Park, Universiti Malaysia Kelantan Jeli Campus, Malaysia (5.747° N, 101.868° E) in June 2022 for initial soil characterization by using a mineral soil auger. The collected soil samples were air-dried, crushed and sieved to pass through a 2 mm sieve.Observation of the selected physical and chemical properties of the soil was carried out by preliminary soil laboratory analysis before the application of the treatment, this was done to see the natural fertility of the soil.

Methodology for soil characterization

Soil texture was determined using a hydrometer method (Tan, 2005). Soil pH and electrical conductivity (EC) were measured in a ratio of 1:10 (soil:water) by using a digital pH meter and EC meter, respectively (Peech, 1965). The loss-on-ignition approach was used to calculate total C and soil organic matter (Tan, 2005). Kjeldahl's approach was used to calculate the total amount of N (Bremner, 1965). The soil-available P and exchangeable cations (K, Ca, and Mg) were extracted using the double acid method described by Mehlich (1953), and K, Ca, and Mg were then determined using an Atomic Absorption Spectrophotometer (AAS) (Analyst 800, Perkin Elmer, Norwalk, USA), while the soil-available P was determined using the molybdenum blue method (Murphy and Riley, 1962). The developed blue colour was analyzed by a UV-VIS Spectrophotometer (Thermo Scientific Genesys 20, USA) at 882 nm wavelengths.

Characterization of bokashi and peat moss

The bokashi and peat moss obtained from the local agricultural products shop in Kelantan, Malaysia. The bokashi and peat moss were characterized for pH, EC, organic matter, total C, and total N using the procedures mentioned above in the soil characterization section. Single dry ashing method was used to extract P and K from the bokashi and peat moss. After that, the total P of the bokashi and peat moss were determined using the molybdenum blue method (Murphy and Riley, 1962). The developed blue colour was analyzed by a UV-VIS Spectrophotometer (Thermo Scientific Genesys 20, USA) at 882 nm wavelengths. On the other hand, Atomic Absorption Spectrophotometer (AAS) (Analyst 800, Perkin Elmer, Norwalk, USA) was used to determine the total K of bokashi and peat moss.

Studyarea and experimental setup

This research was conducted at Agro Techno Park, Universiti Malaysia Kelantan Jeli Campus, Malaysia. The planting experiment was carried out from July until October 2022. A total of 36 planting beds were prepared, and each bed was constructed in the size of 100 cm x 400 cm, consisting of 8 plants bed^{-1}.The experiment was arranged in a Randomized Complete Block design (RCBD). The butternut cultivar used in this planting experiment was aWaltham cultivar.

A total of three different rates of bokashi were applied to the soil prior to planting, namely 0 (control), 4,000, and 8,000 kg ha^{-1} in T_0, T_1, and T_2, respectively. The bokashi used in this study was a commercial bokashi produced from goat litter inoculated with lactic acid bacteria and phototrophic bacteria. A 12,000 kg ha^{-1} of commercial peat moss (Holland Free Peat) was applied in T_4 to compare bokashi and peat moss (the common planting medium used in most planting activities). After applying commercial bokashi and peat moss, 400 kg ha^{-1} NPK and 150 kg ha^{-1} urea were added for each treatment, including T_0 (without bokashi). The Waltham cultivar butternut squash seeds were sown in the sowing tray. The seedlings were then transferred to the beds after two weeks. The planting distance was 50 cmx100 cm, and each bed consisted of 8 plants. After the seedlings had been transferred to the planting bed, the trellis was established.The experiment was monitored daily and stopped on the 100th day after planting, followed by harvesting of butternut squash. The treatment descriptions are presented in Table 1.

Data collection

Plant height, leaf count, leaf length, and leaf width were all evaluated during the planting experiment as indicators of vegetative development. A butternut squash plant's height was gauged from the tip of the shoot to the stem's beginning above the ground. In the first through eighth weeks, plant height was measured. Each plant's total number of leaves was counted from the first to the sixth week. Counting the leaves that emerged from the stem above soil level and continued to the shoot tip were caried out for the calculation of the leaf count. The others vegetative such as width of leaves and length of leaves were measured by randomly choosing three biggest leaves for each plant. The butternut squash was harvestedthe next day after the planting experiment stopped at 100th day when the fruits changed from green to light brown. The weight of the harvested butternut squash was determined and recorded as the total weight of butternut squash per plant.

Data analysis

The vegetative and generative measurement data were analysed using Statistical Package for the Social Science (IBM SPSS) version 21. One-way Analysis of Variance (ANOVA) was used to detect significant difference between the treatmentswhile Tukey's HSD test ($P<0.05$) was used to separate the means between the treatments.

RESULTS AND DISCUSSION

Characteristics of soil, bokashi and compost

The soil characterisation based on the soil analysis results is mentioned in Table 2. The pH of the soil was 4.8, which was classified as very acidic, in this condition butternut squash (*Cucurbita moschata*) growth is not good, because the conditions for growing butternut squash are in the pH range of 6.0-6.8. The soil EC was low. The soil organic matter and total C present in the soil were 3.2% and 1.8%, respectively. The total N in the soil was 0.08%. The available P in the soil was also found to be very low due to the lower soil pH,which contributed to higher exchangeable (acidity, Al, and Fe). The exchangeable cations (K, Ca, and Mg) were higher in the soil.

The characterization of the bokashi and peat moss showed that the pH of bokashi was neutral (7.2), while peat moss had an acidic pH (4.2) (Table 3). The EC of the bokashi and peat moss was low, indicating that they were safe to be applied to the soil for crop cultivation. The C-organic content of the bokashi was high and high organic matter content plays an essential role as a granulator, a source of nutrients and energy for the soil microorganisms (Andayani *et al.,* 2023). In addition, the bokashi also showeda relatively high concentration of total N, total P, total K, and total cations.

Butternut squash plant growth

The weekly measurement of plant height of Waltham butternut squash for T_0-T_3 is shown in Fig.1.The growth pattern of the plant height was sigmoid curved for all treatments from week 1 until 8thweek. The growth performance of T_0-$T_3$from the first week until the second week was slow. The growth accelerated rapidly starting 2nd week until 8thweek. The growth started to stagnate and became constant from 6th week onwards, indicating the plants had reached the maximum growth stage. Waltham butternut squash applied with 8,000 kg ha^{-1} bokashi (T_2) was observed to produce the highest weekly plant height growth (Fig. 1). In terms of statistical comparison, the plant heights across all treatments were not significant in 2nd week (Fig. 2). However, the plant heights significantly differed across the treatments in 5th and 8th weeks. Waltham butternut squash applied with 8,000 kg ha^{-1} bokashi (T_2) was observed to

Table 1. List of treatments assessed in the planting experiment

Treatment*	Description
T_0	0 kg ha^{-1} bokashi
T_1	4,000 kg ha^{-1} bokashi
T_2	8,000 kg ha^{-1} bokashi
T_3	12,000 kg ha^{-1}peat moss

*All treatments (T_0-T_3) were applied with 400 kg ha^{-1} NPK compound fertilizer and 150 kg ha^{-1} urea fertilizer.

produce significantly highest plant height compared to other treatments, and the finding was consistent with that of Fig. 1.This increase in height is thought to be due to the supply of nutrients, especially N, P and K from the applied bokashi (Andayani *et al.,* 2023). Nitrogen (N) is a component of both protein and phosphorus (P), so these two nutrients are crucial for Waltham butternut squash's vegetative growth, particularly plant height. Nitrogen enhances protein synthesis and vegetative development in plants. Root formation and cell division are both influenced by P. As a result, N and P activities helped the plant grow during the early vegetative phase (Hardjowigeno, 2010).

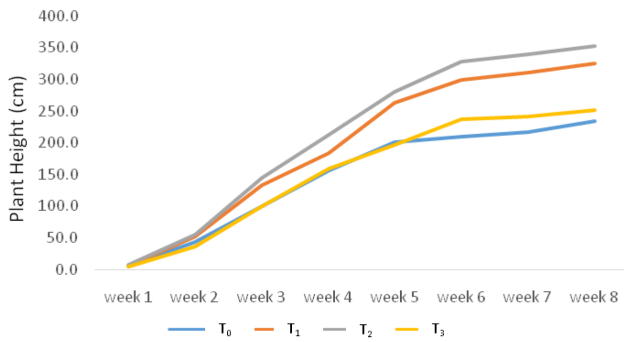

Fig. 1. *Weekly measurements of plant height (1st – 8th week)*

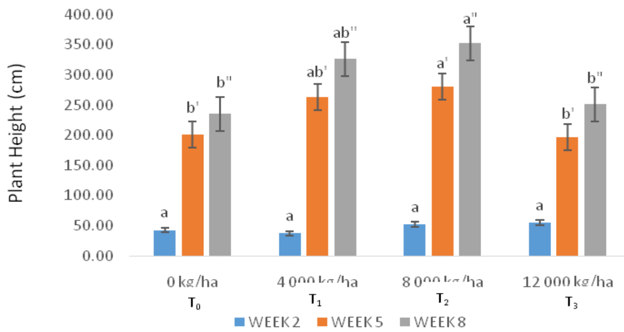

Fig. 2. *Effect of treatments on the plant height across different weeks; Mean values with different letter(s) indicate significant differences between treatments by Tukey's HSD test at P<0.05*

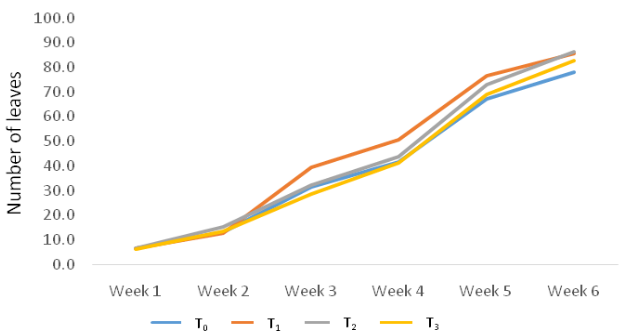

Fig. 3. *Weekly measurements of the number of leaves (1st – 6th week)*

The weekly production ofthe number of leaves from the first week until the 8th week is shown in Fig. 3. The production of leaves was slow and uniform across all treatments between the first week and 2ndweek. However, the leaves production increased rapidly from 3rdweek until 5thweek. This was consistent with the plant height's rapid growth as shown in Fig. 1. The production of leaves started to slow downstarting 6thweek. This indicates that the plants had entered the maximum growth stage. In terms of statistical comparison, number of leaves across all treatments were not significantly dif-

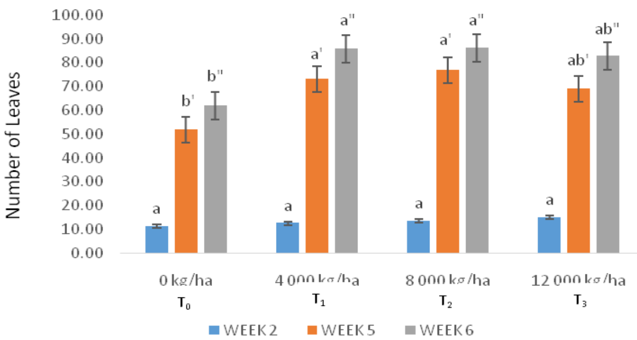

Fig. 4. *Effect of treatments on the number of leaves across different weeks; Mean values with different letter(s) indicate significant difference between treatments by Tukey's HSD test at P<0.05*

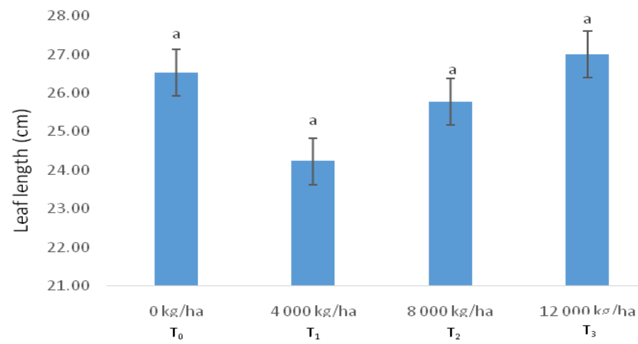

Fig. 5. *Effect of treatments on the leaf length at the end of the experiment; Mean values with different letter(s) indicate significant differences between treatments by Tukey's HSD*

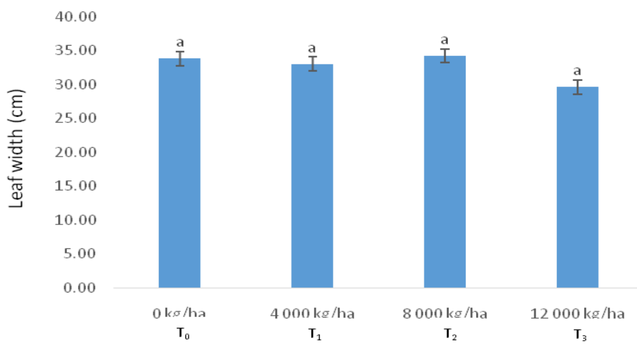

Fig. 6. *Effect of treatments on the leaf width at the end of the experiment; Mean values with different letter(s) indicate significant difference between treatments by Tukey's HSD test at P<0.05*

Table 2. Selected physico-chemical properties of soil prior to planting.

Property	Value Obtained
Soil texture	Sandy loam
Soil pH	4.8
Soil electrical conductivity (dS m^{-1})	0.07
Soil organic matter (%)	3.2
Soil total C (%)	1.8
Soil total N (%)	0.08
Soil Available P (ppm)	2.5
Soil Exchangeable K (ppm)	71.5
Soil Exchangeable Ca (ppm)	134.7
Soil Exchangeable Mg (ppm)	47.3

Table 3. Selected chemical properties of bokashi and peat moss

Property	Bokashi	Peat Moss
pH	7.2	4.2
Electrical conductivity (dSm^{-1})	0.23	0.02
Organic matter (%)	73.6	5.0
Total C (%)	42.7	2.9
Total N (%)	3.0	2.1
Total P (%)	0.7	0.4
Total K (%)	8.3	2.5
C/N ratio	14.2	1.7
C/P ratio	62.7	7.25

ferent. However, treatments applied with 4,000 and 8,000 kg ha^{-1}bokashi (T_1 and T_2) produced the highest number of leaves significantly in 5th and 6th week (Fig. 4) compared to T_0 (0 kg ha^{-1} bokashi). This was due to bokashi improving the physical and chemical conditions of the soil to create favourable conditions for soil microorganisms, which will promote the growth and development of Rhizobium bacteria in fixing N.

The N, P, and K are all essential nutrients for plant vegetative growth, particularly N, which plays a role in arranging chlorophyll.This abundance of leaves will eventually contribute significantly to plant growth during the generative phase, which calls for considerable glucose stores for the flowering and fruiting phase. In the study by Boudet *et al.* (2015), the number of leaves produced for pepper plants (*Capsicum annuum* L.) aged one month was 9.74 under the treatment of 7.5 tons ha^{-1} of bokashi. Similar observation was observed in the cultivation of sweet potato, which indicates that bokashi canincrease plant growth and development of plants (Dou*et al.,* 2012).On the other hand, observation of the leaf length and width of *Cucurbita moschata*during the planting experiment showed that the application of bokashi treatment did not significantly affect the number of leaf length and width across all treatments (T_0-T_3) (Fig. 5 and 6).

The effect of treatment application on the yield of butternut squash can be seen in Fig. 7, where at the end of

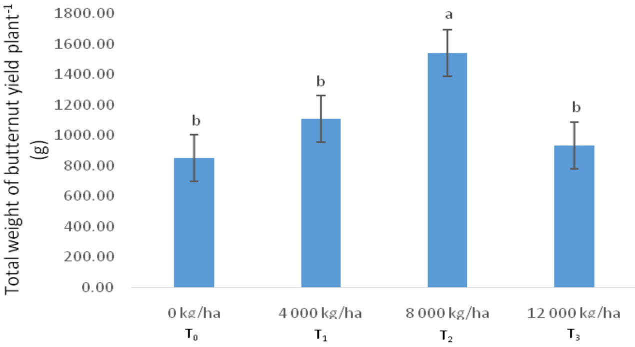

Fig. 7. *Effect of treatments on the total weight of butternut yield per plant; Mean values with different letter(s) indicate significant difference between treatments by Tukey's HSD test at P<0.05*

the planting experiment it showed that the bokashi treatment significantly affected the yield of butternut squash per plant.The bokashi application treatment of 8,000 kg ha^{-1} (T_2) resulted in the significantly highest yield (expressed in total weight $plant^{-1}$), which was 1.5 kg $plant^{-1}$ compared to other treatments. The current finding produced a higher yield weight compared to a study by Kaimuddin *et al.* (2020), which used bio-slurry and NPK fertilization as source of nutrients for butternut squash cultivation. Treatments T_1 (4,000 kg ha^{-1} bokashi) and T_3 (12,000 kg ha^{-1} peat moss) were not significantly different from the treatment of T_0 (0 kg ha^{-1} bokashi).

Conclusion

The present study concluded that butternut squash of Waltham, *Cucurbita moschata* could grow in Malaysia's climate condition, particularly in the Jeli area.The maximum growth of plant height and leaf production for butternut squash was around 7-8th week. Application rate of 8,000 kg ha^{-1} bokashi contributed to significantly highest plant height (352.1 cm), number of leaves (86 leaves), and yield of Waltham butter squash per plant (1.5 kg $plant^{-1}$). It is suggested to carry out multiple planting cycles in the future to elucidate furtherthe residual effect of the bokashi towards nutrient supply to butternut squash cultivation.

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Conflict of interest

The authors declare that they have no conflict of interest.

REFERENCES

1. Anda, M., Shamshuddin, J., Fauziah, C. I. & Syed Omar S. R. (2010). Increasing the organic matter content of an Oxisol using rice husk compost: changes in the composition and its chemistry. *Soil Science Society of America Journal*, 74, 1167-1180. doi.org/10.2136/sssaj2008.0296
2. Andayani, S., Hayat, E. S. & Mursalin, A. (2023). Effect of bokashi quail manure and rice husk biochar on soil pH and soybean plants growth. *IOP Conference Series: Earth and Environmental Science,* 1160, 012023. doi.org/10.1088/1755-1315/575/1/012119
3. Baldotto, M. A. & Baldotto, L. E. B. (2016). Initial performance of corn in response to treatment of seeds with humic acids isolated from bokashi. *Revista Ceres*, 63(1–62), 62–67.doi.org/10.1590/0034-737X201663010009
4. Boudet, A., Chinchilla, V., Boicet, T.& González, G. (2015). Effects of different doses of organic fertilizer type bokashi in morphological and productive indicators of pepper crop (*Capsicum annuum* L.) var. California Wonder. *Centro Agrícola,* 42, 5-9.
5. Bremner, J.M. 1965. Total nitrogen. In Methods of Soil Analysis, Part 2. (pp. 1149-1178). American Society of Agronomy: Madison, WI, USA.doi.org/10.2134/agronmonogr9.2.2ed
6. Christel, D. (2017). The use of bokashi as a soil fertility amendment in organic spinach cultivation (pp. 57). MSc thesis. University of Vermont, Graduate College, Burlington, Vermont, USA.
7. Dou, L., Komatsuzaki, M. & Nakagawa, M. (2012). Effects of biochar, mokusakueki and bokashi application on soil nutrients, yields, and qualities of sweet potato. *International Research Journal of Agricultural Science and Soil Science*, 2(8), 318-327.
8. Ferreira, J., Hernandes, I., Brito, O., Cardoso, M. & Dias-Arieira, C. (2016). Dosages of bokashi in the control of *Meloidogyne javanica* in lettuce, in greenhouse. *Horticultura Brasileira*, 35, 22-229.doi.org/10.1590/S0102-053620170211
9. Hamidi, N.H., Ahmed, O.H., Omar, L., Ch'ng, H.Y., Johan, P.D., Paramisparam, P. & Jalloh, M.B. (2021). Acid soils nitrogen leaching and buffering capacity mitigation usingcharcoal and sago bark ash. *Sustainability*, 13, 1180.doi.org/10.3390/su132111808
10. Hardjowigeno, S. (2010). Soil Science. (pp. 288). Jakarta : Akademika Pressindo.doi.org /10.15243/jdmlm.2022.094.3715
11. Kaimuddin, R. D., Dungga, N. E., Sjahril, R., Mollah, A. & Yuniarti, N. S. (2020). Response of growth and development of butternut squash (*Cucurbita moschata*) to the combination of bio-slurry and NPK fertilization.*IOP Conference Series: Earth and Environmental Science,*575, 012119. doi.org/10.1088/1755-1315/575/1/012119
12. Karimuna, L., Rahni, N. M., & Boer, D. (2016). The use of bokashi to enhance agricultural productivity of marginal soils in Southeast Sulawesi, Indonesia. *Journal of Tropical Crop Science*, 3, 1-6.doi.org/10.29244/jtcs.3.1.1-6
13. Kurniati, F., Hodiyah, I., Hartoyo, T. & Nurfalah, I. (2018). Respons labu madu (*Cucurbita moschata* Dusrch) terhadap zat pengatur tumbuh alami berbagai dosis. *AGROTECH Research Journal*, 2, 16-21.doi.org/10.20961/agrotechresj.v2i1.19466
14. Mehlich, A. (1953). Determination of P, Ca, Mg, K, Na and NH_4. (pp. 145). North Carolina State University Soil Test Division: Raleigh, NC, USA.doi.org/10.4236/jwarp.2011.36052
15. Melo, D. M., Charlo, H. M. O., Castoldi, R., Gomes, R. F. & Braz, L. T. (2013). Nutrient accumulation in "Fantasy" net melon cultivated on substrate. *Semina:Ciências Agrárias*, 34, 1673-1682.doi.org/10.5433/1679-0359.2013v34 n4p1673
16. Murphy, J. & Riley, J.P. (1962). A modified single solution method for the determination of phosphate in natural waters. *Analytica Chimica Acta,* 27, 31–36.doi.org/10.1016/S0003-2670(00)88444-5
17. Paramisparam, P., Ahmed, O.H., Omar, L., Ch'ng, H.Y., Johan, P.D.& Hamidi, N.H. (2021). Co-Application of charcoal and wood ash to improve potassium availability in tropical mineral acid soils. *Agronomy* 11, 2081. doi.org/10.3390/agronomy11102081
18. Paulauskiene, A., Danilcenko, H., Pranckietiene, I. & Taraseviciene, Z. (2018). Effect of different fertilizers on the mineral content of pumpkin fruit. *Journal of Elementology*, 23.doi.org/10.5601/jelem.2017.22.4.1440
19. Peech, H.M. (1965). Hydrogen-ion activity. In Methods of Soil Analysis, Part 2; Black. (pp. 64). American Society of Agronomy: Madison, WI, USA.
20. Tan, K.H. (2005). Soil Sampling, Preparation, and Analysis, 2nd ed. (pp. 672). CRC Press: Boca Raton, FL, USA.doi.org/10.1201/9781482274769
21. Zaman, M., Ahmed M. & Gogoi, P. (2016). Effect of bokashi on plant growth, yield and essential oil quantity and quality in Patchouli (*Pogostemon cablin* Benth.). *Biosciences Biotechnology Research Asia*, 7, 383-387.