LenteraBio, 2025; Volume 14, Issue 2: 163-167

p-ISSN: 2252-3979 e-ISSN: 2685-7871
https://journal.unesa.ac.id/index.php/lenterabio/index

The Effect of Vulcanic Ash as a Nutrition Element on The Growth of Mustard Greens Varieties (*Brassica juncea* L. Var. Tosakan)

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Article History:
Received:
22-July-2024
Revised:
26-February-2025
Available online:
26-February-2025
Published regularly:
31-May-2025

Abstract
Volcanic ash is a solid material in the form of dust released when a volcano erupts. Volcanic ash contains nutrients such as nitrogen, phosphorus, potassium, and a C/N ratio that encourages plant growth. The purpose of this study was to describe the content of nitrogen, phosphorus, and C/N ratio in volcanic ash, to test the effectiveness of volcanic ash administration, and to determine the optimal dose to influence the growth of mustard green plants. This study used an experimental design of a one-factor Randomized Block Design, namely the administration of volcanic ash with different doses to mustard green plants. Treatments A (control), B (125 grams), C (250 grams), D (375 grams), and E (500 grams). The growth parameters observed were plant height, number of leaves, total wet biomass, and wet biomass consumption. Data were analyzed using one-way ANOVA followed by the Duncan test. Based on the results of the study, volcanic ash contains nutrients N (0.31%) (Moderate); P (<0.0074%) (Deficient); and C/N ratio (1.84) (Meager). The administration of volcanic ash dose significantly affected all observed parameters. Treatment with a dose of 500 grams showed the best results on the growth of mustard green plants.

Keywords: Crop; Crop growth; Consumption and resource use; Fertilizer.

How to Cite: Hasanah AQ, Yuliani Y, 2025. The Effect of Vulcanic Ash as a Nutrition Element on The Growth of Mustard Greens Varieties (*Brassica juncea* L. Var. Tosakan). LenteraBio; 14(2): 163-167

DOI: https://doi.org/10.26740/lenterabio.v14n2.p163-167

INTRODUCTION

Mustard green plants have an important meaning; in addition to meeting the nutritional needs of the community, mustard green can increase farmers' income. Mustard green is one of the vegetables popular among Indonesians. The productivity of domestic mustard green is still in the low category; therefore, efforts to increase the productivity of mustard green plants. Mustard is a seasonal plant with many nutrients such as vitamin C, vitamin B, vitamin A, calcium, phosphorus, and protein. In addition, mustard contains a lot of fiber, which helps maintain healthy digestion (Murtafaqoh and Winarsih, 2022). Many phytonutrients are found in mustard greens. These plant-based antioxidants protect your cells from damage and stress caused by free radicals produced by aging, environmental exposures, and our lifestyle choices. Arthritis, immune diseases, heart problems, and cognitive impairment have all been linked to cell damage. In studies, antioxidant activity has been shown to boost immune defenses and reduce the risk of many long-term diseases (Meena *et al.*, 2022).

Soil and plants need minerals such as N, Ca, Na, K, Mg, P and S, and also microelements such as Fe, Mn, Zn, and Cu, these elements are present in volcanic ash formed from volcanic eruptions. Mount Papandayan volcanic ash in Garut Regency, West Java contains Na (3,24%), K (2,45%), Ca (1,50%), Fe (9,05 %), Al (14,00%), Mg (1,13%), Si (48,00%), P (0,13%), Ca (1,50%), dan Ti (0,63%) (El-Desoky *et al*., 2018).

The production of vegetable crops, especially mustard green, needs to be increased and its stability maintained so that the production of mustard green does not experience fluctuations. Based on data from the Central Statistics Agency (BPS) (2022), the production of mustard green in East Java has increased, with 74,395 tons in 2019, 77,716 tons in 2020, and 82,613 tons in 2021. (BPS, 2022). One of the causes of decreased crop yields is the climate and soil lacking nutrients, which leads to reduced growth and development of the plants (Hermawan *et al.*, 2020).

The use of organic fertilizers can be a solution because it can enhance microbial activity, so the activity of organisms in decomposing organic matter can increase the amount of nutrients in the soil, which can be reused by plants (Makaruku, 2015).

Based on preliminary research that has been carried out, volcanic ash from Mount Semeru contains the elements N-total (0.31%), P_2O_5 (<0.0074%), C/N ratio (1.84). Hardjowigeno (2003) stated that the N-total content (0.31%) is in the medium criteria, the P_2O_5 content (<0.0074%) is in the shallow criteria, and the C/N ratio content (1.84) is in the very low criteria. According to SNI (%) 19-7030-2004, the minimum standard is 0.4%, and the Regulation of the Minister of Agriculture no. 28/Permentan/SR.130/5/2009, states that the maximum standard for biological fertilizer, organic fertilizer, and soil improvement is 5.99%. The results of the analysis of the volcanic ash content of Mount Semeru with a value of 0.31%, show that the N-total content of the volcanic ash has met the standard.

This study aims to describe the effect of volcanic ash from Mount Semeru on the growth of mustard green of the Tosakan variety and determine the optimal dose for developing mustard green (*Brassica juncea* L. Var Tosakan).

MATERIALS AND METHODS

This research was an experimental study conducted from February 2024 to April 2024. The research design included a randomized block design, assuming heterogeneous environmental conditions. In this study, there was one treatment factor: the application of several doses of volcanic ash from Mount Semeru, with five treatments and five replications, resulting in 25 experimental combinations, namely: A (control), B (125 grams/polybag), C (250 grams/polybag), D (375 grams/polybag), and E (500 grams/polybag). Nutrient testing of N, P, and the C/N ratio in Mount Semeru's volcanic ash was carried out at the Laboratory of UPT Quality Certification Testing and the Surabaya Tobacco Institute. The experiment was conducted in Ledoktempuro Village, Randuagung District, Lumajang Regency, for one month until harvest time to observe the effect of volcanic ash on the growth of the token variety mustard plants.

The research procedure began with seed preparation. Mustard green seeds were soaked for approximately 15–30 minutes. The seeds were then sown in a tray filled with soil, with each hole containing one mustard green seed. Mustard green plants that had developed four leaves were planted in each polybag according to the treatment and experimental layout design. The planting medium consisted of regosol soil combined with volcanic ash according to the specified dose, stirred until smooth, and placed into each polybag containing 5 kg of planting medium. The preparation of the planting media was completed one week before planting. The care process included watering and efforts to prevent pests, diseases, and weed growth.

Data on the content of N, P, and C/N ratio in the volcanic ash of Mount Semeru were analyzed descriptively using the criteria proposed by Hardjowigeno (2003). Meanwhile, the growth of mustard plants was monitored by measuring the number of leaves and plant height, total wet biomass, and wet biomass consumption over a period of 35 HST, then analyzed using a one-way analysis of variance, and Duncan's test was carried out to evaluate differences between treatments.

RESULTS

The results of this study include data on the content of N, P, and C/N nutrients in volcanic ash from Mount Semeru, as well as growth parameters of mustard plants such as total wet biomass, wet biomass consumption, number of leaves, and plant height. These data were obtained after conducting tests by providing various doses of volcanic ash, which are presented in Table 1 for nutrient content and Table 2 for plant growth parameters.

Table 1. Results of analysis of nutrient content of volcanic ash from Mount Semeru

Number	Parameter	Nutrient Content	Criteria *
1	Nitrogen	0.31%	Medium
2	Fosfor (P_2O_5)	<0.0074%	Very Low
3	C/N Ratio	1.84	Very Low
4	C-Organic	0.97%	Very Low

Note:* Based on the criteria by Hardjowigeno (2003)

Table 2. The average yield of plant height, number of leaves, total wet biomass, and wet biomass consumption of mustard green plants due to the treatment of volcanic ash administration at various doses.

Treatmens	Plant Height	Number of Leaves	Total Wet Biomass	Wet Biomass Consumption
A (control)	4.24 ± 0.47[a]	4.3 ± 0.27[a]	8.94 ± 0.35[a]	7.94 ± 0.35 [a]
B (125 gram)	5.79 ± 0.73[b]	4.62 ± 0.27[a]	15.18 ± 1.42[b]	14.18 ± 1.42[b]
C (250 gram)	7.36 ± 0.45[c]	5.1 ± 0.41[a]	36.72 ± 2.62[c]	35.4 ± 2.63[c]
D (375 gram)	9.02 ± 0.92[d]	6.08 ± 0.58[b]	59.76 ± 4.53[d]	57.74 ± 4.74[d]
E (500 gram)	9.8 ± 1.62[d]	6.9 ± 1.09[c]	82.78 ± 4.78[e]	79.78 ± 4.64[e]

Note: Based on Duncan's test, the difference in notation (a, b, c, d, e) shows a significant difference in the effect between one treatment and another at a level of 0.05.

According to the analysis using the Hardjowigeno's (2003) criteria, the N nutrient content in the volcanic ash of Mount Semeru of 0.31% is categorized as moderate, the P content <0.0074% is categorized as very low, and the C/N ratio of 1.84 is categorized as very low. The nutrients N, P, and C/N ratio affect plant growth (Tabel 1).

The results of the one-way analysis of variance test showed a significant effect of various doses of volcanic ash on all parameters, including plant height, number of leaves, total wet biomass, and wet biomass of plant consumption at an age range of 35 days after planting.

The average results of Duncan's test on plant height parameters at doses of 0 grams, 125 grams, 250 grams, 375 grams, and 500 grams were 4.24; 5.79; 7.36; 9.02; and 9.8. In the parameter of the number of leaves using the Duncan test, the average treatment of 0 grams, 125 grams, 250 grams, 375 grams, and 500 grams was 4.3; 4.62; 5.1; 6.08; and 6.9. The average results of Duncan's test of total wet biomass parameters at doses of 0 grams, 125 grams, 250 grams, 375 grams, and 500 grams produced an average of 8.94; 15.18; 36.72; 59.76; and 82.78. The wet biomass consumption in the treatments of 0 grams, 125 grams, 250 grams, 375 grams, and 500 grams produced an average of 7.94; 14.18; 35.4; 57.74; and 79.78.

The provision of volcanic ash has an impact on the growth of mustard green plants (height, number of leaves, total wet biomass, and consumption). Thus, a dose of 500 grams of volcanic ash showed the best effect on the growth of mustard green plants, while a controlled dose of 0 grams showed the lowest effect (Table 2).

DISCUSSION

Analysis of data regarding testing of Mount Semeru's volcanic ash content (Table 1) shows that Mount Semeru's volcanic ash contains moderate criteria for nitrogen nutrients (0.31%) due to incomplete decomposition activity. The increase in nitrogen elements is caused by the carbohydrate content in the substrate being perfectly converted (Rahmawati *et al*., 2018). The P (Phosphorus) element of Mount Semeru's volcanic ash is classified as very low (<0.0074%). According to Pujiasmanto (2011), this is due to these elements, especially phosphorus, potassium, and other basic elements, which are mostly still combined in the form of primary minerals. In the context of volcanic ash from Mount Semeru, these minerals may not have been completely decomposed or converted into forms that are more readily available to plants. Therefore, although volcanic ash contains elements that are important for plant growth, the availability of optimal nutrients for plants can be influenced by the level of decomposition of these primary minerals. In Table 1, it is known that the C-organic content is very low in volcanic ash. The allophane mineral content in Semeru soil, which is a clay mineral, is thought to cause low P elements. The availability of nutrients, especially phosphorus and nitrogen, is inversely proportional to the presence of allophane (Sihaloho and Kitti, 2021). The allophane content, which has the ability to retain P up to 97.8%, is thought to be the cause of the low available P content (Simanjutak *et al*., 2015).

The elements N, P, and K play an important role in plants. The role of the element N (nitrogen) is to help improve plant vegetative growth and the formation of amino acids and proteins. The role of phosphorus in plants is to help form fruit, develop roots, divide cells, strengthen stems, transfer and store energy, and form nucleoproteins that make DNA and RNA. Potassium plays a role in physiological processes such as starch formation, stomata opening, and increasing plant resistance to drought (Murtafaqoh and Winarsih, 2022).

Mustard greens are able to adapt to various temperature conditions, including cold and hot, therefore mustard greens grow well in both lowlands and highlands. Internal and external factors

affect plant growth and development. One of them is the ability to grow in fertile soil, rich in organic matter, and able to retain water well. Mustard greens grow optimally in fertile soil and are rich in organic matter. The ideal pH for mustard green growth is at (6.5–7.0 pH) (Rana *et al*., 2017).

Nabihaty (2011) explains that genetic factors determine the genetic potential of plants to grow and develop well. However, environmental factors also play an important role because they can affect how well the genetic potential is expressed. An optimal environment, including water conditions, soil nutrients, light, temperature, and others, allows plants to optimize their growth and yields according to their genetic potential. The most important environmental factors for plants include temperature, water supply, carbon dioxide (CO_2), sunlight, nutrient supply, soil reaction (pH), and abiotic factors (Li *et al*., 2020). Fertilizing the soil provides additional nutrients and increases soil fertility and overall plant production. Plant growth can be inhibited if fertilization is done at the wrong time and amount, or if the type of fertilizer chosen does not match the needs of the plant (Murtafaqoh and Winarsih, 2022).

In the study using various doses of volcanic ash, there were significant differences in all growth parameters. This is due to the volcanic ash of Mount Semeru, which contains nutrients N, P, and K, although the N content is in the medium category and the P content is very low. However, it can still meet the nutritional needs of green mustard plants.

Plant height parameters explain that there are significant differences between treatments (Table 2). The volcanic ash treatment with a dose of 375 grams and 500 grams is the most optimal result compared to other treatments. Although the availability of nitrogen in this study is classified as moderate, the provision of different doses in each treatment still allows the mustard green plants to grow optimally. The best treatment is at a dose of 375 grams and 500 grams of volcanic ash with the highest dose, so that the nitrogen elements contained are also increasingly absorbed by the green mustard plants. Treatment of volcanic ash with a dose of 500 grams produced higher plant height compared to volcanic ash treatment at other doses. However, the 375-gram treatment was not much different. This shows that nitrogen helps the vegetative growth of mustard green by increasing plant height. In line with the opinion of Damayanti et al. (2022), nitrogen has the function of vegetative growth, cell elongation, and division in plants and is an essential nutrient found in many tissues, such as growing points.

The volcanic ash of Mount Semeru affects the number of leaves of mustard green plants in various doses (Table 2). This is because the highest dose of volcanic ash was found in the treatment with a dose of 500 grams in other treatments. This can increase the total nutrients needed for maximum growth of green mustard plants. When Kamchatka volcanic ash is introduced into the soil when growing grass and potatoes for fodder, the results of field and production experiments show that this ash can increase soil bioproductivity and is recommended for use in agriculture. The patent was obtained through a formula that improves plant nutrition, which includes the application of mineral fertilizers to incorporate volcanic ash into the soil (Zakharikhina *et al*., 2022). Ardinal et al. (2015) revealed that the benefits of nitrogen in plants function in the formation of green leaves that help photosynthesis activity, increase leaf formation and growth, and improve the quality of plants that produce leaves.

The total wet biomass of mustard greens is one of the parameters of this study. According to the analysis of data on the provision of volcanic ash from Mount Semeru in the treatment between doses, it was significantly different (Table 2). The treatment that obtained the best results was shown by a dose of 500 grams and had a significant effect. In the journal Jayati and Susanti (2019), explained that the availability of ideal nutrients and water content in the leaves caused an increase in the wet biomass of the plant. Water helps maintain cell turgidity, which causes cells to grow larger in the leaves. According to research conducted by Istarofah and Salamah (2017), the absorption of nutrients by the roots affects the wet biomass.

According to the analysis of data on the provision of volcanic ash from Mount Semeru in the treatment between doses, it was significantly different (Table 2). The best results were shown by the 500-gram treatment and had a significant effect; this gave a real effect because the size of the plant was relatively large, possibly supported by the number of leaves, and the chlorophyll content in the plant was also high. Syamsiyah and Rahina (2017) in their journal stated that the wet biomass of plant consumption can be influenced by the number and height of the plant; the higher the plant and the number of leaves, the greater the wet biomass of plant consumption.

CONCLUSION

The results of the study showed that volcanic ash from Mount Semeru contains nutrients of N = 0.31% (medium), P = 0.0074% (very low), and C/N ratio = 1.84 (very low). The provision of volcanic ash has a significant effect on the growth of mustard green plants of the Tosakan variety. The ideal dose of volcanic ash from Mount Semeru for the growth of mustard green was 500 grams/polybag.

ACKNOWLEDGEMENTS

The authors would like to thank Abdurrochman for the valuable support and help during data collection. Our deepest gratitude to the reviewers and editors hence this manuscript improved.

CONFLICT OF INTEREST

There is no conflict of interest.

REFERENCES

Ardinal, Rima SG, Raharjo S and Iskandar R, 2015. Studi Potensi Pembentukan Biogas Dari Sampah Makanan dan Ko-Substrat Feses Sapi Untuk Energi Listrik Alternatif: Studi Kasus Di Universitas Andalas. *Jurnal Litbang Industri;* 5(2): 101-111.

Badan Pusat Statistika. 2022. Data Produksi Tanaman Sayuran Sawi Hijau, (online), https://www.bps.go.id/id/statistics-table/2/NjEjMg==/produksi-tanaman-sayuran.html diakses pada 10 November 2023.

Damayanti, Rossa N, Mutiara D, and Novianti D, 2022. Respons Pertumbuhan Kelor (*Moringa oleifera*) Terhadap Pemberian Unsur Hara Fermentasi Cair Limbah Kulit Nanas *(Ananas comosus* L.). *Indobiosains*; 4(2): 71-76.

El-Desoky A, Hassan A, and Mahmoud A, 2018. Volcanic Ash as a Material for Soil Conditioner and Fertility. *Journal of Soil Sciences and Agricultural Engineering;* 9(10): 491-495.

Hardjowigeno S, 2003. *Ilmu Tanah*. Jakarta: Akademika Pressindo.

Hermawan, Wawan, Noor TI and Setia HB, 2020. Faktor yang Memengaruhi Produksi Sawi Hijau. *Jurnal Agroinfo Galuh*; 7(2): 399 – 410.

Istarofah I, and Salamah Z, 2017. Pertumbuhan Tanaman Sawi Hijau (*Brassica juncea* L.) dengan Pemberian Kompos Berbahan Dasar Daun Paitan (*Thitonia diversifolia*). *Bio-Site Biologi dan Sains Terapan;* 3(1): 39-46.

Jayati, Ria D, and Susanti I, 2019. Perbedaan Pertumbuhan dan Produktivitas Tanaman Sawi Pagoda Menggunakan Pupuk Organik Cair dari Eceng Gondok dan Limbah Sayur. *Jurnal Biosilampari: Jurnal Biologi*; 1(2): 73-77.

Li, Yanqun, Kong D, Fu Y, Sussman MR and Wu H, 2020. The Effect of Developmental and Environmental Factors on Secondary Metabolites in Medicinal Plants. *Plant physiology and biochemistry;* 148(2020): 80-89.

Makaruku MH, 2015. Respon Pertumbuhan dan Produksi Tanaman Selada (*Lactuca sativa* L.) terhadap Permberian Pupuk Organik. Jurnal Agroforestri; 10 (3): 241–246.

Meena KR, Kumari M, Koli KG and Kiran, 2022. Leafy mustard: A healthy alternative to green vegetables. *J. Biotica Research Today*; 4(5): 376-378.

Murtafaqoh VN and Winarsih, 2022. The Influence of Giving Vegetable Waste Leachate as Liquid Organic Fertilizer on the Growth of Mustard Plants (*Brassica juncea* L.). *LenteraBio: Berkala Ilmiah Biologi;* 11(3): 449-456.

Nabihaty F, 2011. Koleksi Pupuk. Laboratorium Kimia dan Kesuburan Tanah, Jurusan Tanah, Fakultas Pertanian, Universitas Gadjah Mada. Yogyakarta.

Pujiasmanto B, 2011. Strategi Pemulihan Lahan Pasca Erupsi Gunung Api (Segi Agroekosistem, Domestikasi Tumbuhan Herba untuk Obat; dan *Action Research*). *Journal of Rural and Development;* 11(2):85-96.

Rahmawati, Dwi I, Purwani IK and Muhibuddin A, 2019. Pengaruh Konsentrasi Pupuk P Terhadap Tinggi dan Panjang Akar Tagetes erecta L. (Marigold) Terinfeksi Mikoriza yang Ditanam Secara Hidroponik. *Jurnal Sains dan Seni ITS;* 7(2): 42-46.

Rana MK, Hooda VS and Sharma B, 2017. Mustard Greens. In Vegetable Crop Science (pp. 403-418). CRC Press.

Sihaloho and Kitti N, 2021. Kajian Sifat Kimia Tanah Pada Lahan Terdampak Abu Vulkanik Gunung Sinabung. Jurnal Agroteknosains; 5(1): 57-66.

Simanjuntak, Magdalena C, Elfiati D and Delvian, 2015. Dampak Erupsi Gunung Sinabung terhadap Sifat Kimia Tanah di Kabupaten Karo. *Peronema Forestry Science Journal*; 4(4): 53-58.

Syamsiyah J and Rahina W, 2017. Ketersediaan dan Serapan Ca Pada Kacang Tanah di Tanah Alfisols yang Diberi Abu Vulkanik Kelud dan Pupuk Kandang. *Agrosains: Jurnal Penelitian Agronomi*; 19(2): 51-57.

Zakharikhina LV, Litvinenko YS and Gainatulina VV, 2022. Volcanic Ash Application in Agricultural Practice. *Universal Journal of Agricultural Research;* 10(1): 77-87.