Penerbit Akademia Baru

Journal of Advanced Research Design

Journal homepage: http://www.akademiabaru.com/ard.html
ISSN: 2289-7984

Optimizing Fruit Growth in Cherry Tomato (*Solanum lycopersicum*): A Zeolite LTA Mass Approach

Norsuhailizah Sazali[1], Zawati Harun[1,*], Norazlianie Sazali[2], Afdhal Junaidi[3]

[1] Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia (UTHM), 86400 Parit Raja, Batu Pahat, Johor Darul Takzim, Malaysia
[2] Faculty of Manufacturing and Mechatronic Engineering Technology, Universiti Malaysia Pahang, 26600 Pekan, Pahang, Malaysia
[3] Institut Teknologi Sepuluh Nopember, 60111 Sukolilo, Surabaya, Indonesia

ARTICLE INFO

Article history:
Received 28 August 2023
Received in revised form 27 October 2023
Accepted 10 November 2023
Available online 19 December 2023

Keywords:
Cherry tomato; fruit growth; Zeolite LTA

ABSTRACT

Cherry tomatoes are highly regarded for their exceptional taste and versatility, receiving recognition in both the field of horticulture and culinary arts. This study examines the importance of zeolite LTA mass as a growth medium in enhancing cherry tomato cultivation in terms of productivity and sustainability. This research was conducted to investigate the effects of incorporating zeolite LTA into the growth substrate on fruit weight. The experiments were designed systematically. The critical metrics undergo thorough measurement and detailed analysis after an 8 and 12-week cultivation period. Our study reveals a clear correlation between the mass of zeolite LTA and the growth of cherry tomato plants. The inclusion of zeolite LTA as a growth substrate has a significant positive impact. The cherry tomato plants treated with this innovative method show significant growth of size fruits weighing up to 104.55 grams. This study demonstrates the potential of using zeolite LTA mass as a growth medium for cherry tomato cultivation, going beyond conventional methods. Furthermore, it enhances our understanding of the complex mechanisms involved in this phenomenon, paving the way for the development of sustainable and efficient horticultural practices. In conclusion, this study is a pioneering contribution to the field of crop science, highlighting the significant impact of using zeolite LTA mass as a growth medium to maximize cherry tomato yields. Moreover, it encourages further investigations into the various uses of zeolites in plant cultivation, highlighting the importance of adopting environmentally conscious approaches in modern agriculture.

1. Introduction

Tomato growth is essential for cherry tomatoes, a distinctively flavored fruit that is extensively utilized across multiple industries [1]. The development of cherry tomatoes can be divided into five stages: germination, initial growth, leaf development within 25 days, a vegetative phase lasting 20 days, flowering and initial fruiting for up to 30 days, and mature fruit taking approximately 20 days to form [2]. The duration of each stage in tomato growth is influenced by factors such as tomato variety and environmental conditions. The vegetative phase encompasses vine growth, leaf and root

* *Corresponding author.*
E-mail address: zawati@uthm.edu.my (Zawati Harun)

https://doi.org/10.37934/ard.73.1.14

development, and flower formation [3]. Flowers indicate the flowering phase, while fruit formation signifies the onset of the initial fruiting phase. A comprehensive grasp of these stages is crucial for the proper maintenance of tomato plants, encompassing watering, fertilization, and pruning [4].

In addition, the potential advantages of zeolite LTA as a soil amendment have drawn interest. Previous studies have revealed its remarkable efficiency in phosphate extraction from water [5], resulting in iron-enriched zeolites that are helpful in soil improvement [6]. Additionally, zeolite LTA has been used to purify contaminated soils, particularly those that contain heavy metals. Numerous fruit and vegetable crops have shown that it is useful in reducing nitrate leaching and boosting nitrogen uptake [7, 8]. Beyond these advantages, it is crucial for reestablishing the soil conditions needed for healthy plant growth, including balancing pH, incorporating organic matter, and enhancing soil structure [9].

Wise selection and application of fertilizer greatly influence the growth of trees that produce fruit [10]. Fertilization must be done with precision, taking into account specific nutrient deficiencies in the soil and the unique needs of each plant. Timing is very important; fertilizer application must be in harmony with the tree's nutrient utilization pattern [11]. Apart from that, the composition and proportion of nutrients in fertilizer must also be in accordance with the plant's needs. So, this study aims to examine the in-depth impact of incorporating Zeolite LTA into the growth medium on aspects of the weight of the fruit produced.

2. Methodology

The experimental procedure requires the utilization of kaolin sourced from Deltacorp Sdn. Bhd., a Malaysian company. Zeolite synthesis commonly employs a primary constituent. The LTA Zeolite Synthesis Method adheres to the procedure outlined in our previous work [12], with minor adjustments. Our metakaolin procedure involved heating kaolin at 600°C for four hours in the furnace. Three grams of metakaolin were slowly mixed with 1M NaOH in a 60-mL beaker. The mélange was stirred at 40°C for 24 hours during aging. We mixed the mixture in an enclosed space to prevent evaporation and drying. After aging, the solution was transferred into a 100-mL Teflon-lined autoclave for crystallization for nine hours at 100 °C. Collection and washing of the supernatant until the solution pH dropped below 9. The remaining solid was heated at 60°C for 12 hours.

After obtaining the LTA zeolite, the next step was to analyze the growth pattern of the cherry tomatoes. This study will make use of controlled experimental greenhouse facilities. The assortment of cherry tomatoes employed originates from the Green World F1 Hybrid cultivar. Each individual cherry tomato will be subjected to a distinct treatment protocol based on the specific levels of nitrogen, phosphorus, and potassium (NPK). A quantity of 12 grams of NPK will be allocated to each pot, followed by the addition of varying amounts of LTA zeolite. In the control pot, no LTA zeolite was included, while in the subsequent three pots, 2, 4, and 6 grams of LTA zeolite were respectively incorporated. Throughout the 8 and 12-week intensive cultivation period carefully collected comprehensive measurements, and performed detailed analyzes of key metrics of cherry tomato fruit weight.

3. Results

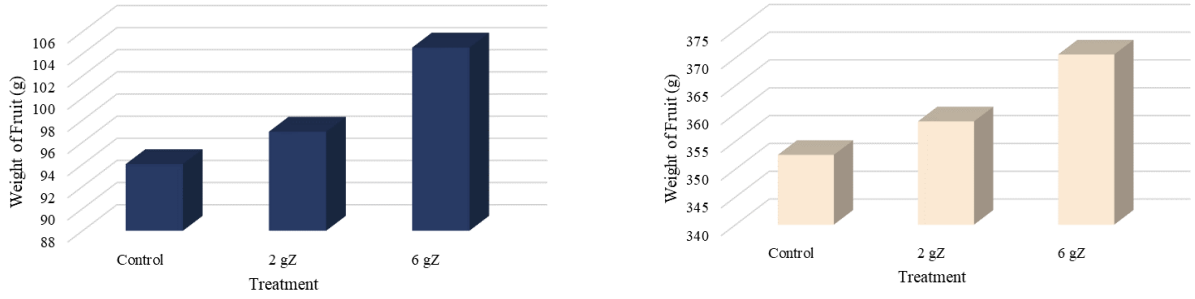
The weight of cherry tomatoes that resulted from the growth process that took place over the course of eight weeks has been successfully collected, and the results can be seen in Figure 1 and Table 1. It is clear to see that the maximum value that could be obtained from a zeolite sample of 6 grams after 8 weeks of growth reached 104.44 grams. An increase of 11.20 percentage points was found when measured against the standard sample. In the meantime, there was an increase of 7.93%

when compared to a sample that consisted of 2 g of zeolite. Therefore, the addition of LTA zeolite can, in general, increase the growth of cherry tomatoes; specifically, the greater the mass of LTA zeolite that is added, the greater the mass of cherry tomatoes that are produced. The harvesting process can be completed in a span of one year. After adding 6 grams of zeolite to the mix, the mass of the cherry tomatoes that were grown reached a new all-time high of 370.58 grams. When compared to the control group and then to 2 g of zeolite, this result was found to have an increase of 5.12% and 3.35%, respectively. According to these findings, there were not an excessive amount of changes that occurred in comparison to the amount of zeolite that was added.

Table 1
The impact of various treatments on the weight of fruits.

Treatement	Weight of fruits (g)	
	8 weeks	12 weeks
Control	94.015	352.53
2 gZ	96.95	358.56
6 gZ	104.55	370.58

Zeolites have been shown to improve the structure of the soil and the conditions of the soil's nutrients, both of which are associated with an increase in crop yields for a wide variety of plant species [13]. According to the findings of this study, increasing the amount of zeolite that was worked into the ground in conjunction with either synthetic or organic fertilizer resulted in a greater overall yield of fruit. This is due to the fact that zeolites are renowned for their high cation exchange capacity as well as their ability to retain moisture. Therefore, it should not come as a surprise that adding zeolite to a plant's diet in the form of a nutritional supplement can improve the plant's ability to make effective use of nutrients and increase the amount of water that it takes in by those plants, including cherry tomato plants. According to Bernardi *et al.,*[14], this capability also has the potential to improve the soil's physical and chemical properties. When viewed from the perspective of the structure of the zeolite, which contains an aluminum oxide network in three dimensions, it is possible for the zeolite to gain and lose water in a reversible manner, and it also facilitates the exchange of elements with benefits without altering the fundamental structure [15].



(a) (b)

Fig. 1. The effect of treatment on increasing fruit mass for (a) 8 weeks and (b) 12 weeks

4. Conclusions

The findings of the research led to the conclusion that the addition of LTA zeolite to soil can improve the quality of the soil and lead to an increase in the production of cherry tomatoes. This is because CEC zeolite has the ability to increase growth while also preserving the moisture content of

the soil. The addition of 6 grams of zeolite led to an increase of 104.55 grams at week 8 and 370.58 grams at week 12, which produced the best possible results.

Acknowledgement
This research was funded by Universiti Malaysia Pahang (Grant number RDU232707)

References

[1] Soriano, T., M. I. Morales, I. Escobar, E. M. Suarez-Rey, J. Hernandez, I. Romacho, N. Castilla, and O. Hita. "The growth and yield of cherry tomatoes in net covered greenhouses." In *International Symposium on Greenhouse Cooling 719*, pp. 529-534. 2006. https://doi.org/10.17660/ActaHortic.2006.719.61

[2] Rahim, Hairazi, M. A. M. A. Wahab, Mohd Zaffrie Mat Amin, Azahar Harun, and Mohd Tarmizi Haimid. "Technological adoption evaluation of agricultural and food sectors towards modern agriculture: Tomato." *Economic and Technology Management Review* 12, no. 5 (2017): 41-53.

[3] Li, Xinping, Xiaoling Liu, Ke Zhang, Hongbing Luo, Aiping Pu, Daiwei Zhuang, Bing Jiang et al. "Controlling methane emissions from Integrated Vertical-Flow Constructed Wetlands by using potassium peroxymonosulfate as oxidant." *Journal of Environmental Management* 325 (2023): 116444. https://doi.org/10.1016/j.jenvman.2022.116444

[4] Hussain, K., Sameena Lone, Ajaz Malik, Khalid Z. Masoodi, Z. A. Dar, Nageena Nazir, Gowher Ali, and Syeda Farwah. "Genetic variability studies in cherry tomato for growth, yield, and quality traits in open field conditions." *International Journal of Agricultural and Applied Sciences* 2, no. 2 (2021): 60-64.

[5] Guaya, Diana, Hernán Cobos, Jhulissa Camacho, Carmen Milena López, César Valderrama, and José Luis Cortina. "LTA and FAU-X Iron-Enriched Zeolites: Use for Phosphate Removal from Aqueous Medium." *Materials* 15, no. 15 (2022): 5418. https://doi.org/10.3390/ma15155418

[6] Jarosz, Renata, Justyna Szerement, Krzysztof Gondek, and Monika Mierzwa-Hersztek. "The use of zeolites as an addition to fertilisers–A review." *Catena* 213 (2022): 106125. https://doi.org/10.1016/j.catena.2022.106125

[7] Min, Ju, Hailin Zhang, and Weiming Shi. "Optimizing nitrogen input to reduce nitrate leaching loss in greenhouse vegetable production." *Agricultural water management* 111 (2012): 53-59. https://doi.org/10.1016/j.agwat.2012.05.003

[8] Sazali, N., W. N. W. Salleh, A. F. Ismail, N. H. Ismail, F. Aziz, N. Yusof, and H. Hasbullah. "Effect of stabilization temperature during pyrolysis process of P84 co-polyimide-based tubular carbon membrane for H2/N2 and He/N2 separations." In *IOP Conference Series: Materials Science and Engineering*, vol. 342, no. 1, p. 012027. IOP Publishing, 2018. https://doi.org/10.1088/1757-899X/342/1/012027

[9] Patel, Arzoo, Roshni Patel, and Bharat Maitrey. "A REVIEW-IMPORTANCE OF PHYSICO-CHEMICAL PROPERTIES IN SOIL QUALITY." *VIDYA-A JOURNAL OF GUJARAT UNIVERSITY* 1, no. 2 (2022): 51-54. https://doi.org/10.47413/vidya.v1i2.60

[10] Wadchasit, Pornwimon, Nirattisai Rakmak, O. Sompong, Ubolluk Rattanasak, Tsuyoshi Imai, Sarawut Jitpinit, and Kamchai Nuithitikul. "Improvement of biogas production and quality by addition of struvite precipitates derived from liquid anaerobic digestion effluents of palm oil wastes." *Journal of Environmental Chemical Engineering* 11, no. 1 (2023): 109081. https://doi.org/10.1016/j.jece.2022.109081

[11] Lansche, Jens, and Joachim Müller. "Life cycle assessment (LCA) of biogas versus dung combustion household cooking systems in developing countries–a case study in Ethiopia." *Journal of cleaner production* 165 (2017): 828-835. https://doi.org/10.1016/j.jclepro.2017.07.116

[12] Sazali, Norsuhailizah, Zawati Harun, Tijjani Abdullahi, Faiz Hafeez Azhar, Azlinnorazia Ahmad, Nurul Izwanie Rasli, and Norazlianie Sazali. "Potential of transforming sodalite from synthesis kaolin with a mild condition of the hydrothermal method." *Biointerface Res Appl Chem* 12 (2022): 7376-7393. https://doi.org/10.33263/BRIAC126.73767393

[13] Butorac, A., T. Filipan, F. Basic, J. Butorac, M. Mesic, and I. Kisic. "Crop response to the application of special natural amendments based on zeolite tuff." *Rostlinna vyroba* 48, no. 3 (2002): 118-124. https://doi.org/10.17221/4210-PSE

[14] de Campos Bernardi, Alberto Carlos, José Carlos Polidoro, Marisa Bezerra de Melo Monte, Elaine Inácio Pereira, Cauê Ribeiro de Oliveira, and Kulasekaran Ramesh. "Enhancing nutrient use efficiency using zeolites minerals—A review." *Advances in Chemical Engineering and Science* 6, no. 04 (2016): 295. https://doi.org/10.4236/aces.2016.64030

[15] Liu, Dongna, Yun Zhang, Anchao Zhou, Emmanuel N. Nnachi, Shuting Huo, and Qi Zhang. "The Kaolinite Crystallinity and Influence Factors of Coal-Measure Kaolinite Rock from Datong Coalfield, China." *Minerals* 12, no. 1 (2021): 54. https://doi.org/10.3390/min12010054