



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

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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

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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 and Discussion

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

Treatment	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].

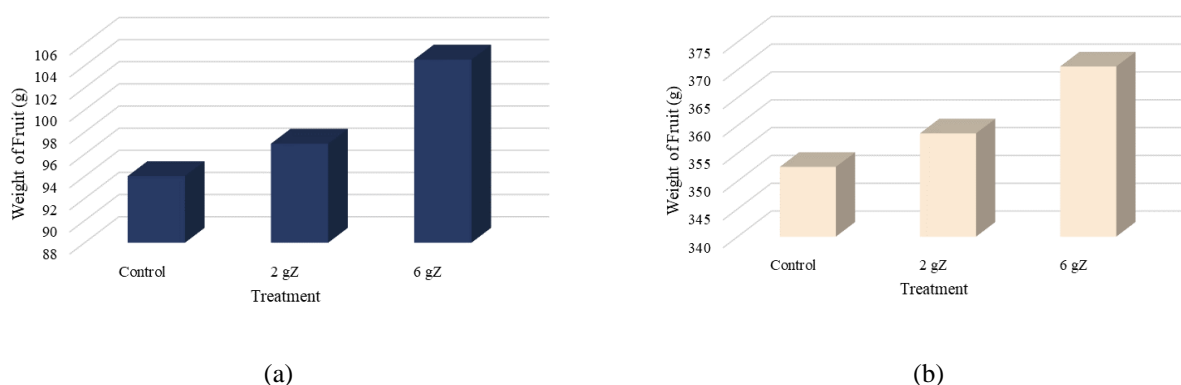


Fig. 1. The effect of treatment on increasing fruit mass for (a) 8 weeks and (b) 12 weeks

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.

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