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The Effect of Ethylene Gas Exposure of Tomatoes (*Solanum lycopersicum*) on the Morphological Growth of Green Beans (*Vigna radiata*)

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Abstract: Ethylene is one of the natural growth hormones produced by fruits such as tomatoes, and is known to have an important role in regulating various plant physiological processes. This research was conducted to examine the effect of natural ethylene gas from tomatoes on the early growth of green bean plants (*Vigna radiata*). The research used a simple experimental method with two treatment groups, namely the group of plants exposed to ethylene gas from tomatoes and the control group without ethylene exposure. The observed parameters include stem height and root length in a certain period of time. Observation results show that exposure to ethylene affects the growth of green bean plants, especially in increasing the height of the stem which is more significant than control plants. Based on the findings, it can be concluded that ethylene gas produced naturally by tomatoes has the potential to accelerate the early growth of green bean plants.

Keywords: Ethylene, green beans, growth, hormone, tomato.

Introduction

Plant growth and development are controlled by the body's own processes and by conditions in the surroundings. One of the key plant growth regulators is ethylene, a gas-like hormone that helps control many different growth processes. Ethylene gas is a clear gas that is part of a group of hydrocarbons called unsaturated compounds, and its chemical formula is C2H4 (Mubarok *et al*., 2020). Ethylene gas is often used to start the ripening process in climacteric fruits, as mentioned in Charloq's 2024 study. Ethylene is present in parts of plants like leaves, stems, fruits, and roots (Kanaya *et al*., 2021). Plants make more ethylene when they face problems like not enough water, too much water, being pressed physically, or getting sick (Wardani *et al.,* 2014). Oxygen levels also affect how much ethylene is made, and if there's less than 2% oxygen, it can stop the process of creating ethylene (Wardani *et al*., 2014).

Tomatoes are a horticultural commodity with significant economic value in Indonesia (Sari *et al*., 2021). Tomatoes are not only used as vegetables but have also developed into a fruit commodity with increasing market demand (Nurjannah *et al*., 2021). Tomatoes contain a variety of nutrients that are beneficial for human health (Wibisana *et al*., 2024).

Mung beans are food ingredients that are processed and have a high economic value, especially when used as seeds (Syakira *et al*., 2025). Mung beans are commonly used by people in Indonesia (Hidayanti *et al.* 2022). Mung beans can help improve how well your digestive system works because they contain fiber, as stated in Nahak's 2021 study. This plant can be picked in a short period and can survive in dry conditions (Suhartono *et al.,* 2020). Mung bean yield depends on choosing the right variety, having enough land, good soil nutrients, and proper farming techniques (Anhar *et al*., 2022). The growth of mung bean plants can be influenced by outside factors like water, temperature, humidity, sunlight, the type of soil, and how much nutrients are available (Azhari *et al.,* 2018). Genetic factors are also very important in controlling how plants grow (Jiao *et al*., 2019).

While ethylene is crucial in plant biology and tomatoes inherently generate ethylene gas, the precise effect of ethylene emanating from tomatoes on the initial morphological development of mung bean plants is not well understood. The majority of current research emphasizes ethylene's role in fruit ripening or overall plant reactions, leaving a gap in understanding its direct effects on various plant species during their early growth stages. This scenario leads to a research inquiry about whether exposure to natural ethylene can influence stem height and root length in the early stages of seedling growth.

Prior investigations have explored the influence of ethylene on the maturation of fruits and the physiology of plants (Mubarok *et al.,* 2020). Studies have also focused on the use of ethylene in the ripening processes of climacteric fruits (Charloq, 2024). Additionally, other research has outlined how plants respond to ethylene when faced with environmental stress (Wardani *et al*., 2014). Investigations related to the yield of mung beans and influencing cultivation aspects have been performed as well (Anhar *et al*., 2022). Nevertheless, there remains a lack of studies that specifically examine the direct impact of natural ethylene gas generated by ripe tomatoes on mung bean seedlings through a straightforward experimental approach. Consequently, there exists a gap in research regarding how the natural ethylene released from tomatoes interacts with the initial morphological development of mung beans.

In light of the recognized gap, this research intends to investigate how natural ethylene gas released by tomatoes affects the initial growth of mung bean plants (*Vigna radiata*). The emphasis of this study is on measuring stem height and root length following exposure to ethylene. The significance of this research is rooted in offering a straightforward experimental method to comprehend the physiological effects of natural ethylene interactions among different plant species, potentially enhancing fundamental understanding in plant physiology and its practical applications in agriculture.

Materials and Methods

Time and Place

This research was conducted at the Biology Education Laboratory of Sultan Ageng Tirtayasa University (UNTIRTA) for five days, from April 16 to 20, 2025. On the first day, activities were carried out in the laboratory for initial preparation and material setup. Observations and treatments were continued at the researcher's home for four days, under normal room temperature conditions.

Research Method

This study used an experimental method with two different types of treatments on mung bean seeds (*Vigna radiata*). The tools used included ventilated plastic jars, dropper pipettes, tweezers, beakers, rulers, and scissors. The materials used consisted of tomatoes (*Solanum lycopersicum*), mung beans (*Vigna radiata*), paper plates, water, cotton, label paper, and latex gloves. The main material, mung beans, was first selected using tweezers to ensure good quality.

Research Procedure

The research begins with the selection of high-quality mung beans using a sorting process. Then, the study is carried out in two treatments, namely:

1. Treatment 1 (Control): Five mung bean seeds are placed in a jar without any additives.
2. Treatment 2: Five mung bean seeds are placed in a jar, and then one tomato is added as the treatment.

All jars are placed under room temperature conditions. Observations are conducted over five days, from the first day to the fifth day, recording physical changes such as stem height, root length, and the number of leaves each day.

Data Analysis

The data is analyzed descriptively based on daily observations, including stem height, root length, and the number of leaves from the first day to the fifth day. Information for each parameter is observed regularly to determine the effect of tomato treatment on the growth of mung beans.

Results and Discussion

Results

Bud Growth Analysis

The research results show differences in root and stem length in mung bean plants

between the control treatment and the treatment applied with tomato. Each treatment was physically observed for root length, stem length, and the number of leaves after several days of growth. These observations are presented in Table 1 and Table 2 below.

Table 1. Observation result on the green bean control

Root length	Leaf length	Number of leaves	Picture
2,3 cm	17 cm	2 Sheet	

Table 2. Observation results on green beans + tomatoes

Root length	Leaf length	Number of leaves	Picture
8 cm	16,6 cm	2 Sheet	

Discussion

Observing Table 1, mung beans that were not exposed to ethylene from tomatoes showed roots reaching a length of 2.3 cm and stems reaching 17 cm. The leaves formed totaled 2. The stem appeared to grow straight, upright, and symmetrical without any curvature. This condition indicates that growth occurred well without interference from external substances such as ethylene gas. Stem length during the germination phase is influenced by general growth factors, both external and internal. Nutrition, especially water, is an external factor contributing to the height of germinating mung bean plants. Meanwhile, the hormone auxin is an internal factor affecting the stem height of seedlings (Ernita *et al*., 2023). The early stage of a plant's life is called germination. This process begins when the seed absorbs water. Then, the seed can obtain water from its environment. Water can enter through water vapor, dew, or in the form of gas (vapor) (Kencana *et al.,* 2023). In the early phase, plants naturally concentrate energy and growth hormones to elongate the stem vertically in order to capture sunlight as efficiently as possible with the help of the hormone auxin (Nurita & Yuliani, 2023). The still short root growth indicates that water and nutrient absorption has not yet become a primary focus, as the plant is still in the early stage of development and has not yet experienced environmental stress. This is due to seed viability being highly influenced by environmental conditions and other factors (Sivana *et al.,* 2024).

In Table 2, the sprouts that were exposed to tomatoes experienced very significant changes. Their root length increased significantly to 8 cm, while their stems were slightly shorter than the control, measuring 16.6 cm. The shape of the stems was no longer straight but appeared curved. Although the number of leaves remained unchanged, this change in stem shape indicates that growth was different. This demonstrates the influence of chemicals released by the tomatoes, namely the ethylene gas, which can affect the direction of sprout stem growth. According to Tahri *et al.* (2023), ethylene gas will reduce turgor pressure within the cells; this occurs because of the triple response that causes the cells to widen. This expansion makes the epidermal cell shapes more elongated.

Furthermore, according to Ningsih *et al.* (2016), ethylene gas can promote epinasty, which is a movement where the stem and leaf tips curve downward due to excessive cell growth on the upper part of the leaf stem. In seedlings exposed to ethylene gas from tomatoes, there is a more significant root elongation, a finding supported by research by Dimitry N Neljubow, a Russian physiologist who first revealed that ethylene affects plant growth, including changes in root structure (Asra *et al.,* 2020). In addition, (Faqih, 2021) notes that there are other factors that can accelerate root growth, namely storage in darkness, due to the influence of the hormone

auxin, which plays an important role in the cell elongation process of young shoots, and in sunlight exposure, the performance of this hormone becomes suboptimal. The auxin hormone not only helps strengthen roots but also plays a role in initiating new root growth, improving root quality, and supporting root growth uniform (Noviyanti *et al.,* 2021).

When the two treatments are compared, it is observed that the presence of tomatoes affects two important aspects of plant growth, namely root length and stem shape. The control plants grew taller and straight, but had shorter roots (Zega *et al*., 2024). In contrast, plants placed with tomatoes had longer roots, but their stems were shorter and curved. This indicates that natural compounds released by tomatoes, such as ethylene gas, can stimulate root growth while simultaneously disrupting the direction of stem growth. Ethylene is a compound that acts as an inhibitor of cell elongation, thereby slowing plant growth (Asra *et al.,* 2020). In plants exposed to ethylene, physiological changes can indeed be clearly observed in the shape and length of the stems.

Ethylene is known to affect plant height reduction and cause morphological changes, including stem bending (Nurdiana, 2022). One study showed that the reduction in plant height was caused by the shortening of tracheids in response to mechanical disturbance or stress, while ethylene levels tend to increase severalfold after the plant experiences stress. This affects the structure of plant tissues, particularly the stem, and may explain why green bean stems exposed to ethylene from tomatoes curve and do not grow as upright as the control (Pradani *et al.,* 2020). Thus, although ethylene can have positive effects on certain parts of the plant such as the roots, an imbalanced concentration can also have negative effects on other parts such as the stem.

Conclusion

Based on the research results, it can be concluded that natural ethylene gas produced by tomatoes has a significant effect on the early growth of mung bean plants (Vigna radiata). The data shows that seedlings exposed to ethylene gas from tomatoes experienced much longer root elongation. However, exposure to this ethylene gas also caused the stems to change shape, becoming curved instead of straight. This change indicates that ethylene gas affects plant growth differently in different organs, namely promoting root growth while simultaneously inhibiting stem growth and altering its shape. This can be explained by the effect of ethylene gas causing changes in cell turgor pressure and stimulating epinasty, which is the bending of plant organs, resulting in the mung bean stems curling. These findings indicate that although ethylene gas from tomatoes can act as a root growth stimulant, its presence needs to be controlled so that it does not inhibit stem growth and disrupt the overall morphology of the plant.

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