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Effects of Liquid Organic Fertilizers and Boron Application on Growth of Tomato (*Solanum lycopersicum*) in Soilless Media

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Abstract: A study was conducted to determine the effects of liquid organic fertilizers as well as boron (B) application on growth of Solanum Lycopersicon (tomato) in soilless culture media which was using cocopeat as growth media. There were 16 treatments with 5 replications, including Controls (unapplied and AB fertilizer), liquid organic fertilizers (fish amino acid [FAA] and shrimp extract [SE]) and B application. Each experiment was carried out for 8 weeks arranging in a factorial randomized complete block design (RCBD) as an experimental design. Data were analyzed and the differences between treatments mean were compared using Tukey HSD test with significant level ($P<0.05$). Results showed that the treatments were significantly affected the plant height ($F_{15,368} = 12.51$, $P \leq 0.001$) and number of leaves ($F_{15,368} = 19.14$, $P \leq 0.001$). This study proved that the application of liquid organic fertilizers (FAA and shrimp extract) and B application can contribute positive effects on plant growth for certain parameters only. However, they can also be used as an alternative fertilizer to reduce the usage of chemical fertilizer.

Keywords: Fish amino acid, shrimp extract, boron, tomato, soilless culture, plant growth

1. Introduction

Tomato (*Solanum lycopersicum*) is a member of the Solanaceae family. As the most popular fruiting vegetable among home gardeners and a crop of significant commercial and scientific value, tomato (*Solanum lycopersicum*) are also the most popular fruiting vegetable overall (Heuvelinm, 2018). Tomato is perennial plant, but because it is sensitive to frost, it is planted as warm-season annual crops. It can be grown in both greenhouses and open fields. It was also appropriate for a variety of climes, from moderate to hot and humid tropical (Dam et al., 2005). Tomato are suitable for planting in soilless culture system including others fruiting crop such as chili, capsicum, zucchini, rock melon, eggplant and strawberry (Mahamud et al., 2002).

Tomatoes are now grown more frequently soilless in greenhouses to improve plant nutrition and a decline in soil-borne illnesses (Baudoin et al., 2013). Growing media, often known as "substrates," or solid rooting media, are the foundation of many soilless growing methods (Conac et al., 2013). In soilless agriculture, the growing media that is used is crucial. Materials have a wide range of physical and chemical properties such as coco peat. It is extracted from coconut husk in fiber as an agricultural by-product. Cocopeat is made into the potting mix, which is done carefully to maintain the porosity and the water retention is maximum. Cocopeat has adequate physical and chemical making it a suitable medium for growing plants. Cocopeat has a pH value of 6, which is optimum for most crops (Putra & Yuliando, 2015).

Industry improved agricultural yields per unit of land in order to meet the growing population's demand for food, but they also increased the usage of synthetic fertilizers in agriculture. However, the extensive use of chemical fertilizers in agriculture to ensure the security of the world's food supply has led to a substantial number of health problems and lasting environmental deterioration. Therefore, in the modern period, a new approach to agriculture called organic agriculture, sustainable agriculture, or ecological agriculture was developed to decrease and eliminate the harmful effects of synthetic fertilizers on human health and the environment (Keeney & Follett, 1991). Organic fertilizers are substances

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Fertilizers in liquid form are used for application that can be mix with irrigation water. The ease of handling, lower labor demand, and potential for combination with herbicides have increased farmers' acceptance of liquid fertilizers. Phibunwatthanawong & Riddech (2019) claimed that Thailand uses liquid organic fertilizers made from leftover agricultural material and industrial waste. Liquid organic fertilizers such Fish Amino Acid (FAA) and Shrimp Extract (SE) have been used recently in agriculture sector.

Fish amino acid is a liquid organic manure generated from fish excrement. It has a wide range of minerals and amino acids, is very helpful for the growth of plants and microorganisms (Priyanka et al., 2019). According to Ramesh et al. (2020), who studied Amaranthus, fermented FAA is an organic acid that is utilized as a fertilizers addition and contains significant compounds that affect plant growth and development.

High-value shrimp are processed for their meat, leaving behind their hard shell and heads as processing waste (Knorr, 1991). Massive amounts of solid waste are created during the industrial processing of shrimp, and this trash is a major source of animal protein, chitin, carotenoids, and other bioactive substances that are not properly exploited. However, shrimp heads contain a variety of beneficial bioactive substances that may have significant commercial applications in a variety of industries, including food, medicine, feed, cosmetics, aquaculture, biotechnology, and others (Hajji et al., 2014).

The nutrients in the soil, the soil's structure, and the biological and physical characteristics that encourage soil fertility were all improved by the shrimp shell waste. Additionally, it can increase soil microbial activity and decrease parasitic nematode populations. Shrimp shell waste-derived chitin and chitosan can lessen tomato root galls and stimulate plant growth by lengthening shoots and increasing yield (Radwan et al., 2012). Additionally, the chitosan from shrimp shell waste increased the yield's quality while storing it and protected it from disease (Hossain & Iqbal, 2016).

In addition, Boron (B) is one of microelements which required for plant growth and quality of tomato. Boron application can increase fruit hardness, fruit set, total yields, marketable yields, and fruit yields (Davis et al., 2003). According to Smit and Combrink (2013), boron shortage in plants caused them to have pale-green, fragile leaves.

Due to this problem, numerous researchers worked to develop an organic fertilizer that farmers could use without endangering the ecology and ecosystem. The purpose of the study is to determine the impact of fish amino acid (FAA) shrimp extract (SE) as well as boron application on tomato plant growth and development in soilless media.

2. Materials and Methods

2.1 Plant Materials and Experimentation

The seeds of tomato were germinated for three weeks under the nursery. After three weeks the seedlings were hardened-off and transplanted to the polybags. Each polybag was contained 1kg of dried cocopeat as a growth media.

The preparation of FAA by using waste product of the long-jawed mackerel was mixed with molasses according to the ratio 1:1 to create the liquid organic fertilizer, which was then fermented for three weeks. The mixture was filtered three weeks later. As the study's treatments, various volumes of this solution were used. For shrimp extract, the waste product from the shrimp was combined 1:1 with molasses to create this liquid organic fertilizer, which was then treated for three weeks. The mixture also was filtered three weeks later.

The experiment was used two different types of liquid organic fertilizers which were fish amino acid (FAA and SE) and AB fertilizer as A control treatment (Table 1). The treatments were given direct to the media twice a week meanwhile for boron foliar spray, the treatments were given once a week. Each treatment was conducted in RCB design with five replications. Data were collected for 8 weeks after planting.

Table 1: Treatments for soilless culture

	Treatments
T1	Control (No treatment
T2	1.87 mg/L B
T3	10 ml/L FAA
T4	10 ml/L FAA + 1.87 mg/L B
T5	20 ml/L FAA
T6	20 ml/L FAA + 1.87 mg/L B
T7	30 ml/L FAA
T8	30 ml/L FAA + 1.87 mg/L B
T9	10 ml/L shrimp extract
T10	10 ml/L shrimp extract+ 1.87 mg/L B
T11	20 ml/L shrimp extract
T12	20 ml/L shrimp extract + 1.87 mg/L B

T13	30 ml/L shrimp extract
T14	30 ml/L shrimp extract + 1.87 mg/L B
T15	Control (AB treatment)
T16	Control (AB treatment) + 1.87 mg/L B

2.2 Plant Height Determination

Plant height from each treatment were measured weekly by using a standard measuring tape. The results of the measurement were recorded.

2.3 Number of Leaves Determination

Plant number of leaves from each treatment were determined weekly. The results of plant number of leaves were recorded.

2.4 Shoot Biomass Determination

All the plants from each treatment were put in an envelope and labelled according to the treatments. All the samples were dried in an oven at 70^{O}C for 24 hours. Then the samples were weighed by using a digital scale.

2.5 Root Biomass Determination

All the root from each treatment were put in an envelope. All the samples were dried in an oven at 70^{O}C for 24 hours. Then the samples were weighed by using a digital scale.

2.6 Soil pH Determination

Soil pH was determined using pH meter according to the particular ratio (1:2.5; fresh soil: distilled water).

2.7 Statistical Analysis

This factorial experiment was laid in a Randomized Complete Block Design (RCBD). Data were analyzed using software called Statistical Package for the Social Sciences (SPSS) was used to conduct the statistical analysis. The data were analyzed by using one- way analysis of variance (ANOVA) and compared by using Tukey test. The 95% confidence interval ($P \leq 0.05$) was used to estimate the significant of the difference.

3. Results and Discussion

3.1 Plant Height

There were significant differences of plant height among the treatments (Fig. 1). Treatment T5 and T7 showed the significant effects compared to other treatments. According to Priyanka et al. (2019), who reported that foliar spray fish amino recorded considerably increased plant height on green gram. This increased nitrate availability from the soil and foliar application of fish amino acid, which promoted cell division and metabolic activity and raised plant height at all growth stages.

For boron application, results showed that there were significant differences of plant height among the treatments especially for treatment T6, T8 and T16. These results are accordance to Naz et al. (2012), who said boron showed significant effect on the growth and yield of tomato.

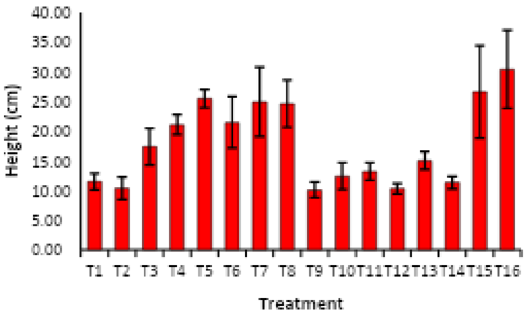

Fig. 1: Effect of liquid organic fertilizers and boron on plant height

3.2 Plant Number of Leaves

There were significant differences of plant number of leaves among the treatments (Fig. 2). Treatment T3, T5 and T7 showed the significant effects compared to other treatments. These results are similar according to Xu et al. (2021), who demonstrated that boron may stabilize leaf structure and successfully stimulate the synthesis of photosynthetic pigments, which directly improve tomato plants' ability to photosynthesize.

For boron application, result showed there were significant differences of plant number of leaves among the treatments especially for treatment T4, T6, T8 and T16. The previous study also reported that tomato which receiving soil or foliar applied B had better growth and were more productive compared to plant that did not apply boron (Davis et al., 2003).

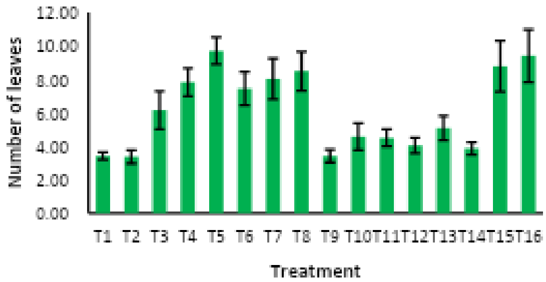

Fig. 2: Effect of liquid organic fertilizers and boron on plant number of leaves

3.3 Shoot Biomass

There were no significant differences of shoot biomass among the treatments (Fig. 3) either for liquid organic fertilizers or after boron application. However, Treatment 5 was significantly higher than Treatment 1 after application of organic fertilizers. Meanwhile, for boron application, Treatment 6 was significantly difference compared to Treatment 2. These findings contrasted with the study by Xu et al. (2021), who discovered that boron treatments had a substantial impact on tomato plant biomass accumulation. The fresh weight and dry weight of shoots were both enhanced by boron treatment to the leaves and the roots, however the root application produced larger root and shoot dry weight ratios than the leaf application did.

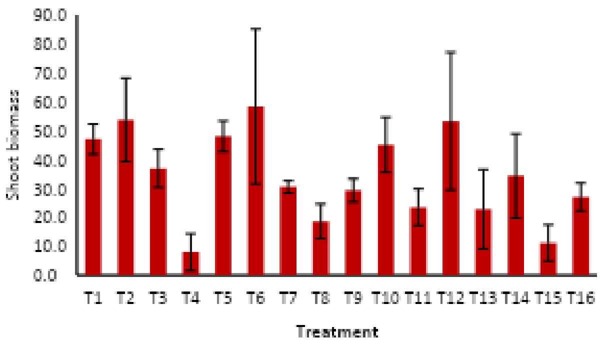

Fig. 3: Effect of liquid organic fertilizers and boron on shoot biomass

3.4 Root Biomass

There were no significant differences of root biomass among the treatments (Fig. 4) either for liquid organic fertilizers or boron application. However, Treatment 13 was significantly higher than Treatment 1 after application of organic fertilizers. Meanwhile, for boron application, Treatment 10 was significantly higher than Treatment 2. These results were different to Davis et al. (2003) who reported boron has an important function in cell wall metabolism and the stability of root structure which effect to plant biomass.

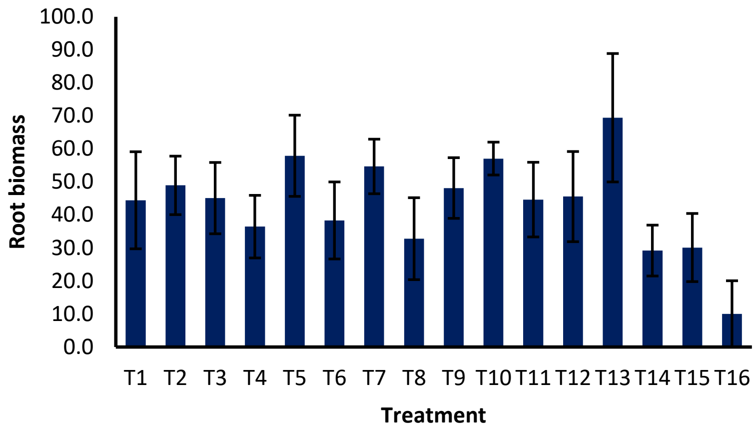

Fig. 4: Effect of liquid organic fertilizers and boron on root biomass

3.5 Soil pH

There were no significant differences of soil pH among the treatments (Fig. 5) either for liquid organic fertilizers or boron application. The soil pH was at the range 6.2-6.5. However, according to Harahap et al. (2020) who said that organic fertilizers contain a complete nutrient, although the amount is little, organic fertilizers also help the process of weathering of mineral materials, such as member availability of food material for microbes, decrease the activity of harmful microorganisms, and neutralizes the pH of the soil.

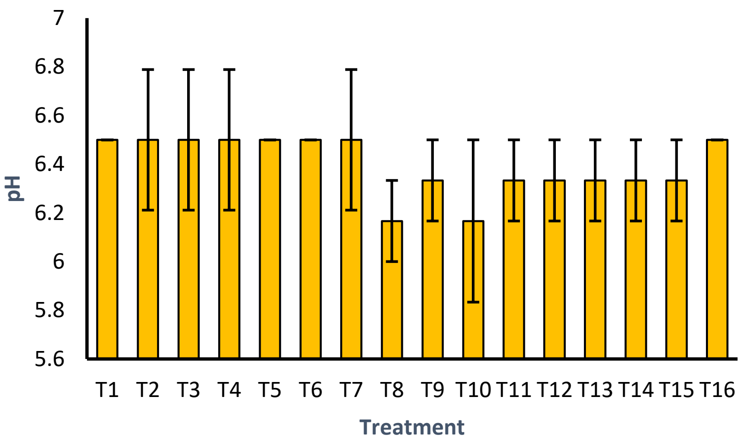

Fig. 5: Effect of liquid organic fertilizers and boron on soil pH

4. Conclusion

Results showed that Treatment 5 (20 mL FAA) and Treatment 7 (30 mL FAA) gave the better results compared to the treatments using shrimp extract and AB fertilizers. Meanwhile, for boron application which are Treatment 6 (20 mL FAA + 1.87 mg/L B) and Treatment 8 (30 mL FAA + 1.87mg/L B) gave the better result compared to other treatments. It showed that fish amino acid (FAA) appears to be a promising alternative to chemicals fertilizers.

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Conflict of Interest

The authors declare no conflicts of interest.

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