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# EFFECTIVENESS OF FERMENTED FRUIT JUICE APPLICATION ON FLOWERING AND YIELD OF *Solanum Melongena*

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**Abstract:**

The use of chemical fertilizer might be effective for crop yields. However, it can cause pollution in a long terms period and reduce the quality of the soils. The growers tend to use chemical fertilizer as it is fast release fertilizer and able to produce a higher yield. Fermented Fruit Juice (FFJ) is an organic fertilizer which has been used in natural farming practices. It is produced by using natural ingredients as fruits and molasses. Besides being useful to promote flowering and fruiting, Fermented Fruit Juice can also be used as a foliar spray. Thus, a study was carried out to evaluate the effects of Fermented Fruit Juice (FFJ) application on the flowering and yield of *Solanum melongena*. The experimental design was a complete randomized design (CRD) with three treatments and four replications; T1 (30g of NPK green 15:15:15 and 40g of NPK blue 12:12:17), T2 (NPK 15:15:15 & FFJ) and T3 (solely FFJ). FFJ was prepared using over-ripe *Musa acuminata* fruits with brown sugar and left fermented for seven days. The first application of FFJ was done at two weeks after transplanting and the second application was done after one month after transplanting. The result shows that there is no significant difference among the treatments applied on plant height and number of flowers. However, T2 (application of NPK fertilizer together with FFJ) is effective in inducing the number of fruits. Furthermore, T2 resulted in significantly higher fruit fresh

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weight as compared to T3 (solely FFJ). Thus, it can be concluded that FFJ can be applied as plant stimulant in inducing flowering and the number of fruits for *Solanum melongena* to reduce chemical fertilizer amount by combining FFJ with NPK fertilizer.

**Keywords:**

Fermented Fruit Juice, Natural Farming, Flowering, Yield, *Solanum Melongena*

## Introduction

Malaysia is one of the countries that focuses on agriculture sector development. Agriculture sector contributed 8.2 per cent which is equal to RM96.0 billion to the Gross Domestic Product (GDP) in 2017 (Department of Statistic Malaysia, 2018). However, it is recorded that Malaysia is the fourth most fertilizer dependent countries in world after Qatar, Singapore and Seychelles. It is stated that 1726.60 kg per hectare of fertilizer is used on the arable land in Malaysia. Arable land is land that is capable of plowing and planting crops (Seth, 2017). Farmers in Malaysia tend to use chemical fertilizer as it is easy to obtain and does not require rigid process to apply it to crops. Unfortunately, too much fertilizer application will eventually decrease the quality of soil and increases soil acidity. Moreover, this type of fertilizer becomes one of the factors of water pollution. It is because fertilizers used in the fields is drained through rainfall and sewage to the rivers, lakes, and oceans and harmed the aquatic ecosystem. The fertilizer run-offs also cause underground water contamination which is used for domestic purpose (Seth, 2017). Furthermore, crop production alone is thought to be the source of about 60% of the nitrogen pollution, mainly through the use of nitrogen (N) fertilizers (Aryal et al., 2021). Natural farming use methods that follow the laws of nature and utilization of natural materials and products. It is based on the principle of interdependence between all living things. The goal is to have a nurturing impact on the environment as modernized and commercialized agriculture nowadays bring harms to the environment. This method will help our country to reduce over reliance on chemical fertilizer use for agriculture sector. The purpose of this study is to to evaluate the effects of Fermented Fruit Juice (FFJ) application on the flowering and yield of *Solanum melongena*.

## Literature Review

There are a few points will be discussed in literature review of the study of effectiveness of fermented fruit juice application on flowering and yield of *Solanum melongena.*

### *Solanum Melongena L.*

*Solanum Melongena L.* or known as eggplant, brinjal, aubergine or Guinea squash is a plant of a night shade family Solananceae. The fruit shapes and colours of *Solanum melongena L.* variations range from oval or egg-shaped to long club-shaped, and from white, yellow, green to degrees of purple colouring to virtually black (Al Ali et al.,2019). Moreover, eggplant is classified as a dicotyledon, and has a long tap root (Mahamad, Samah, & Khidzir, 2022). Brinjal has 4% carbohydrate content, has a high biological value of protein and amino acids, and higher vitamin content than many other vegetables but has lower content of vitamin B2 (Rama & Narasimham, 2003). Furthermore, the flavonoids, phenolic acids, and tannins found in eggplant have been reported by numerous researchers (Hasan, 2021). The eggplant fruit is harvested when it is physiologically immature (Hasan, 2021). According to Al Ali et al. (2019), brinjal is an essential crop throughout Asia, Africa, and the subtropics (India and Central

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America), and it is also grown in some warm temperate regions of the Mediterranean and South America.

***Fermented Fruit Juice (FFJ)***

Fermented Fruit Juice, referred to as FFJ, is a type of an organic fertilizers that is used to increase the yield of fruiting plant. The usage of fermented fruit juice is same as fermented plant juice also known as FPJ and they are easy to be prepared. Tagotong (2015) stated that organic fertilizers like Fermented Fruit Juice (FFJ) is good source of plant nutrients and beneficial to physical properties of soil that which important for the vigor growth and development of plants. Banana, papaya, mango, grape, melon, apple, and other non-citrus fruits can be used to make fermented fruit juice. However, papaya, watermelon, and banana have characteristics that can help plants become stronger and healthier (Vani et al., 2023). According to Vani et al. (2023), the banana is abundance with potassium, which encourages fruiting while papaya and watermelon have a lot of chlorophyll and chromoplast in plants. Additionally, FFJ contain vital microorganisms that may solubilize P and K for use by crops. (Sulok et al., 2021).

Several studies have been conducted in the application of FFJ to investigate the effect of FFJ on plant development and yield. In the study of FFJ on growth and yield of tomato plant by Abd Rahim et al. (2017), the tomato plant treated FFJ have impact on higher plant height compared to control and there were significance differences in number of flowers and fruits produced by tomato plants treated by FFJ after transplant. During reproductive stages of plants, Cho's Global Natural Farming (Reddy, 2011) stated that it is suggested to apply FFJ during reproductive stage in order to supply calcium which required at reproductive stage. There are also findings by Al Ali et al. (2019) on the study of yield and plant vegetative growth of eggplant. They studied that there was no significant difference in number of fruit produced by *Solanum melongena* between organic fertilizer, developed organic fertilizer and chemical fertilizer. They explained that organic fertilizer application to the soil able to increase mineral content in soil. Furthermore, it was discovered that sixty ml of FFJ is needed to attain optimum flowering in the study of growth, flowering performance and seed yield of sunflower (*Helianthus annuus*) applied with FFJ and rice water (Zurbano, Merjudio, Alcantara, Remando, & Arela, 2023).

## Material and Methods

***Study Site***

This study was conducted from December 2019 until March 2020 in Plantation Unit, UiTM Perlis at plantation plots.

***Plants Material Preparation***

One seedling tray with 104 holes was filled with peat moss to use for seed germination. Two seeds of *Solanum melongena* was put into each holes of seedling trays. The seedling trays was then misted and wrapped using black plastic and let it germinate in fully dark condition. After two days, the plants were unwrapped and let it germinate for two weeks. The seedlings were transferred to nursery for hardening off. Then it was transplanted into polybags with planting medium (3 loam: 2 organic matter: 1 sand).

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***Treatment Preparation***

There were three treatments T1 (NPK 15:15:15 & NPK 12:12:17), T2 (NPK 15:15:15 & FFJ) and T3 (FFJ only) with four replications and the total number of sixty plants were used to conduct this research. For this experiment, the chemical fertilizer used was from Behn Meyer AgriCare. For first application, 30g of NPK 15:15:15 meanwhile for second application, 40g NPK 12:12:17 was applied to each plant in ring placement method (Hosnan, 2017). 1 ml of FFJ was mixed with 1L of water and applied to plant through irrigation (Burhanuddin et al., 2006).

***Fermented Fruit Juice (FFJ) Preparation***

The preparation of Fermented Fruit Juice was based on Manual of Natural Farming in Malaysia from Department of Malaysia. For Fermented Fruit Juice (FFJ) preparation, 1 kg over ripe *Musa acuminata* fruits, 1 kg brown sugar, paper, a plastic container were used. One kilogram of banana var Berangan (*Musa acuminata*) was cut into small pieces and mix with one kilogram of brown sugar. Then the mixture was put into plastic container, covered by using paper and tied using rubber band. Left the mixture under shady area and fermented for five to seven days. Lastly, the mixture was filtered using thin cloth and pour the solution until 2/3 of container (Burhanuddin et al., 2006).

***Treatment Application***

The treatment was applied two weeks after transplanting on February 2020. After one month, second application of fertilizer is done on March 2020. For chemical fertilizer (NPK), it was applied by spreading the granule to the corner of the polybags meanwhile for FFJ application, it will be dissolved in water before applying it to the soil. The experimental design used was a completely randomized design with 4 replications. The planting distance is 60cm x 60cm between the plants.

**Table 1: List of Treatments Applied on *Solanum Melongena***

| Treatments | Rate | |
|---|---|---|
| | **First application** | **Second application** |
| T1 | NPK 15:15:15 (30g/plant) | NPK 12:12:17 (40g/plant) |
| T2 | NPK 15:15:15(30g/plant) | 1000 ml water + 1 ml FFJ per plant |
| T3 | 1000 ml water + 1 ml FFJ per plant | |

***Statistical Analysis***

Statistical analysis was conducted using Statistical Package for Social Science (SPSS) software package version 24.0. The data was analysed using Analysis of Variance (ANOVA) subjected to one-way ANOVA. In order to determine statistically significant and the means are separated using post hoc Tukey HSD test ($p \leq 0.05$). Diversity index were firstly proposed by Jaccard (1912) and Gleason (1922).

**Results and Discussion**

***Plant Height***

Plant height of *Solanum melongena* were recorded in centimeters during the day of transplanting until harvesting, 0, 30, 60 and 90 days after transplanting. *Solanum melongena*

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that were treated with different types of fertilizer show significant differences ($p \leq 0.05$) in plant heights after fertilizer application (Table 4.1). During 30 DAT until 90 DAT, there is a significant difference ($p \leq 0.05$) for a plant height between a plant that applies with NPK 15:15:15 + FFJ (T2) as compared to the plants that only used FFJ (T3). However, the height of a plant that used NPK 15:15:15 + NPK 12:12:17 (T1) did not shows significant difference as compared to height of plant in T2 and T3. This result is similar to a finding by Al Ali et al. (2019) where there were no significant differences of vegetative growth of *Solanum melongena* treated with organic fertilizer, developed organic fertilizer and chemical fertilizer.

According to Abd Rahim et al. (2017), the tomato plants treated with FFJ had higher plant height compared to control. They reported that there were no significant differences between control and plants treated with FFJ in their research as it is might be due to errors during process of making the fertilizers or pest and disease attacks. However, in this study, the results show there was significant differences between T2 (30g of NPK 15:15:15 and FFJ) and T3 (FFJ only) as $p \leq 0.05$. It is demonstrated that FFJ is suitable to be applied during reproductive stages of plants and not suitable to apply it during growing stages as it is lacks of nutrients needed by plants during growing stage.

**Table 2: Effects of Different Types of Fertilizer Application on Heights of *Solanum Melongena* before Transplanting, 30, 60 and 90 Days after Transplanting.**

| Treatment | Plant height (cm) | | |
|---|---|---|---|
| | Day after transplanting (DAT) | | |
| | 30 | 60 | 90 |
| T1 | $11.91^{ab}$ | $25.79^{ab}$ | $36.17^{ab}$ |
| T2 | $13.81^{a}$ | $28.18^{a}$ | $39.75^{a}$ |
| T3 | $10.71^{b}$ | $19.8^{b}$ | $28.15^{b}$ |

Note. Mean value within a column followed by the same latter is not significantly different at $p \leq 0.05$ according to Tukey method. Data are mean values of ten plants. Note. T1: 30g of NPK 15:15:15 and 40g of NPK 12:12:17, T2: 30g of NPK 15:15:15 and FFJ, T3: FFJ only. Note. Data presented is ± standard deviation of mean.

***Flower Anthesis***

The first flowering of *Solanum melongena* was recorded in order to determine whether FFJ help to reduce the time taken for flowers to appear. It is recorded by counting the days after transplanting until the day first flower appeared.

Figure 1 displays day of flowering of *Solanum melongena* after being treated with different types of fertilizer. In the present study, different types of fertilizer does not affect the day of flowering of eggplants. Plant treated with solely FFJ had the lowest mean of day of flowering compared to plant treated with chemical fertilizer and plant treated with chemical fertilizer added with FFJ. However, there are no significant differences on day of flowering among three treatments.

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Based on Figure 1, it is shown that there was no significant difference between time taken for first flowering of *Solanum melongena*. T3 (FFJ only) has the lowest mean values of time taken for first flowering which shows that plants treated with FFJ can produce first flowers in shorter times. However, since there was no significant difference on day of flowering between all the treatments so, it cannot be proved that FFJ help to boost appearance of flowers compared to conventional compound NPK fertilizer.

The finding of Mante et al. (2016) revealed that orchid treated with Fermented Plant Juice (FPJ) showed significant difference in day of flowering as it is the earliest to initiate floral formation between another organic treatments. The result from this finding shows that organic fertilizer can be used as to boost initiation of flowers.

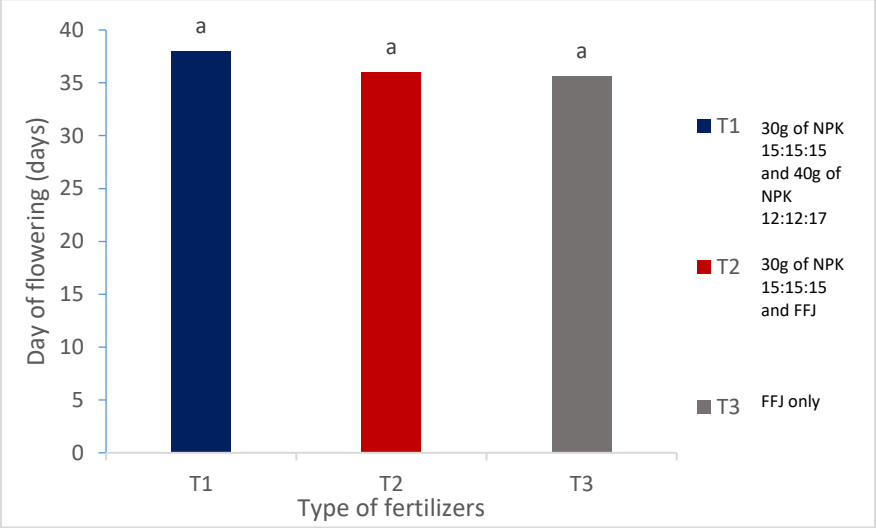


**Figure 1: Effects of Different Types of Fertilizer Application on Day of Flowering for *Solanum Melongena.* Different Letters on Top of Bars Indicate Significant Differences (P≤0.05). Note. Vertical Bars Represent ± Standard Deviation of Mean.**

***Number of Flowers***

Total number of flowers were recorded at 30 and 90 DAT after plants being treated with fertilizer. At 30 DAT, first application of fertilizers was done and at 90 DAT, second application of fertilizers was done. Mean values of the number of flowers was collected from five individual plants from each treatment.

Figure 2 displays number of flowers of *Solanum melongena* after being treated with different types of fertilizer. In the present study, different types of fertilizer does not affect the number of flowers of eggplants. Plant treated with chemical fertilizer only, plants treated with chemical fertilizers with added FFJ and plants treated with solely FFJ had no significant difference regarding the number of flowers.

As from Figure 2, it is shown that there was no significant difference on number of flowers produced by *Solanum melongena* after applying different types of fertilizers as p value is more than 0.05. T2 (30g of NPK 15:15:15 and FFJ) had the highest mean values of number of flowers at 30 DAT while T1 (30g of NPK 15:15:15 and 40g of NPK 12:12:17) had highest mean values of number of flowers at 90 DAT.

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This result differ from findings by Abd Rahim et al. (2017) where there were significant differences in number of flowers and fruits produced by tomato plants treated by FPJ and FFJ after transplant. Based on manual of Cho's Global Natural Farming (Reddy, 2011), it is recommended to apply FFJ during reproductive stages of plants in order to supply calcium needed during this stage. Thus, inaccurate data might be due to pest and disease attack and weather condition which cause the flowers do not bloom or fall off from stems.

Besides, findings by Mante et al. (2016) showed that Dendrobium treated with Fermented Plat Juice (FPJ) significantly had higher percentage of flowering than other organic fertilizer including Fermented Fruit Juice (FFJ). This shows that plants treated with organic fertilizer can produce high number of flowers but FPJ is the most effective compared to other organic fertilizer.

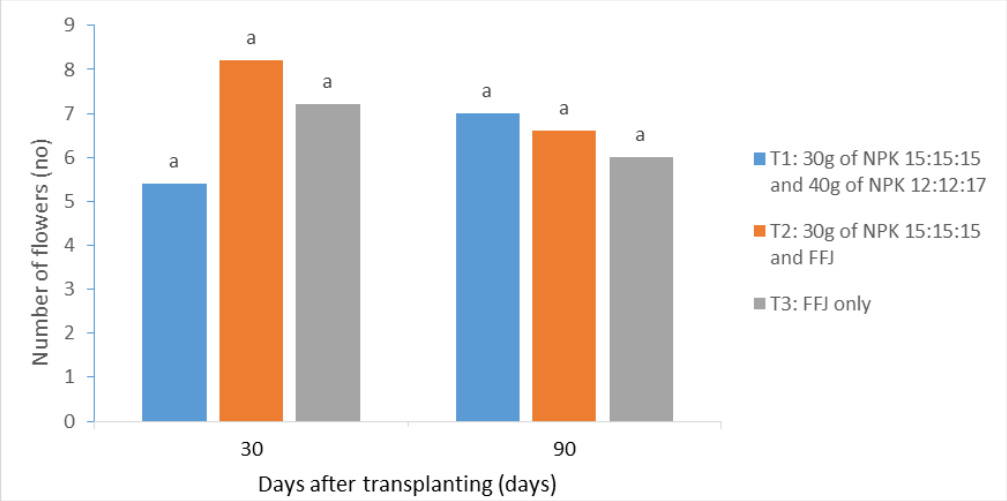


**Figure 2: Effects of Different Types of Fertilizer Application on number of Solanum Melongena Flowers. Different Small Letters on Top of Bars Indicate Significant Differences (P≤0.05). Note. Vertical Bars Represent ± Standard Deviation of Mean.**

***Number of Fruits***

Figure 3 displays number of fruits of *Solanum melongena* after being treated with different types of fertilizer. In the present study, different types of fertilizer affect the number of fruits of eggplants. Plants treated with chemical fertilizers with added FFJ and plants treated with solely FFJ had a significant difference regarding the number of fruits. However, the application of chemical fertilizers only does not have significant different in number of fruits produced by eggplants when compared to plants treated with chemical fertilizers added with FFJ and plants treated with solely FFJ.

Based on Figure 3, the highest mean value of number of fruits is T2 (30g of NPK 15:15:15 and FFJ). After tested with post hoc Tukey HSD test, there is significant difference between T2 and T3 as $P \leq 0.05$. Thus, this shows that application of T2 (30g of NPK 15:15:15 and FFJ) is more effective compared to T3 (FFJ only). It also proves that the application of FFJ is effectives for fruiting and not suitable to be used during growing stages of *Solanum melongena*.

The value of P is more than 0.05, hence, there is no significant difference between T1 and T2. Thus, it cannot be proven that the use of FFJ as fertilizer is more effective to produce higher

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yield of *Solanum melongena* compared to conventional compound NPK fertilizer. However, this result is different from the finding of Abd Rahim et al. (2017) where there was significant differences for number of flowers and fruits produced by tomato plants treated by FPJ and FFJ after transplant compared to chemical fertilizer. Inaccurate result occurred due to pest and disease attacks that cause damages to the fruits which decrease yield of fruits.

This result is similar to Al Ali et al. (2019) that there was no significant difference in number of fruits produced by *Solanum melongena* between organic fertilizer, developed organic fertilizer and chemical fertilizer. Thus, Al Ali et al. (2019) explained that applying organic fertilizer to the soil can increase mineral content in soil.

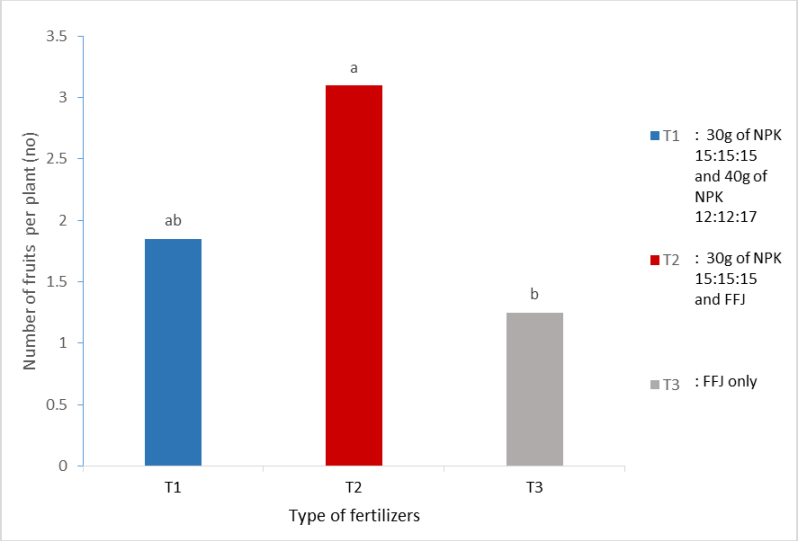


**Figure 3: Effects of Different Types of Fertilizer Application on Number of *Solanum Melongena* Fruits. Different Letters on Top of Bars Indicate Significant Differences (P≤0.05). Note. Vertical Bars Represent ± Standard Deviation of Mean.**

***Fresh Weight of Fruits***

Figure 4 displays fresh weight of *Solanum melongena* fruits after being treated with different types of fertilizer. In the present study, different types of fertilizer affect the fresh weight of eggplants. Plant treated with chemical fertilizers with added FFJ had significantly higher fruit fresh weight as compared to solely FFJ. However, the application of chemical fertilizer was not significantly different in fresh weight of fruits compared to plants treated with chemical fertilizer added FFJ.

As from Figure 4, it shows that there was a significant difference ($P \leq 0.05$) in fresh weight of *Solanum melongena* between different types of fertilizer applications. Plants treated with T1 (30g of NPK 15:15:15 and 40g of NPK 12:12:17) and T2 (30g of NPK 15:15:15 and FFJ) had higher fruit fresh weights compared to T3 (FFJ only). There was a significant difference between T2 (30g of NPK 15:15:15 and FFJ) and T3 (FFJ only) plants as $P \leq 0.05$ when tested with post hoc Tukey HSD test. Thus, this shows that FFJ fertilizer is proven effective during reproductive phases and not suitable to be used during growing phases. However, there was no significant differences between T1 (30g of NPK 15:15:15 and 40g of NPK 12:12:17) and T2 (30g of NPK 15:15:15 and FFJ). The inaccurate result is due to several reasons such as pest attack and errors during process of making FFJ fertilizers.

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It is stated in manual of Cho's Global Natural Farming (Reddy, 2011) that potassium content in the leaf will be used during fruit enlargement period as lot of potassium is transferred to the fruit. FFJ made from banana contains 1.2% of potassium elements as stated in manual of Natural farming (NF) in Malaysia (2006). Thus, this might prove that the weight of *Solanum melongena* fruits that treated with FFJ has higher weight compared to conventional compound NPK fertilizer.

As from the previous study by Butay et al. (2018), they reported that peach trees treated with Fermented Plant Juice (FPJ) produced the highest number of fruits, and in turn had higher return of investment with 28.93 percent as compared to chemical fertilizer. This similar to the findings of Tagotong (2015) where organic fertilizers like Fermented Fruit Juice (FFJ) is good source of plant nutrients is beneficial to physical properties of soil that which important for the vigor growth and development of plants.

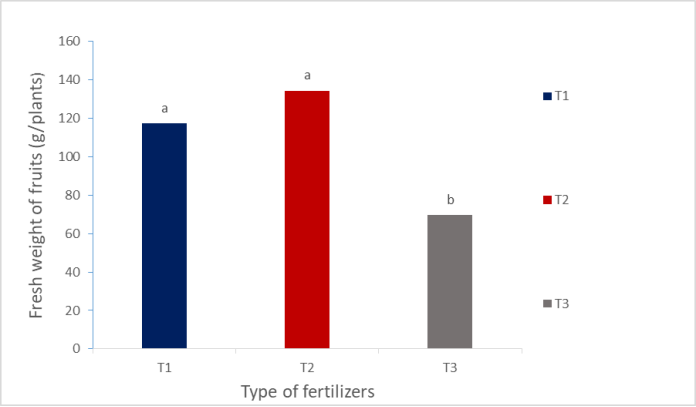


**Figure 4: Effects of Different Types of Fertilizer Application on Fresh Weight of *Solanum Melongena* Fruits. Different Letters on Top of Bars Indicate Significant Differences (P≤0.05). Note. Vertical Bars Represent ± Standard Deviation of Mean.**

## Conclusion

As for conclusion, the plant height was increased with the application of NPK together with FFJ. Based on the results obtained, there was no significant difference among treatments on total number of flowers. However, number of fruits was increased with NPK together with FFJ. Solely FFJ application has potential to shorten the days of flowering meanwhile chemical fertilizer extended the vegetative growth and lengthen the days of flowering although there is no significant difference among the treatments. FFJ can be applied as plant stimulant as substitution to the chemical fertilizer (NPK blue) in inducing number of flowers, number of fruits, fruits fresh weight. The cost of preparation of FFJ is also cheaper compared to the price of chemical fertilizer. As for recommendation, further study should be performed by applying FFJ to other plants with different concentration to determine the most effective performances of FFJ towards plants. Furthermore, FFJ are highly recommended to apply on other vegetable crops such as chilli, okra or tomato in promoting flowers and yield of those plants. Overall, the objectives of the study was achieved because the application of FFJ showed effectiveness on the flowering and yield of *Solanum melongena* fruit either apply FFJ solely or in combination with NPK fertilizers. These findings can benefit to academic and the nation as FFJ is efficient to use for planting in the agricultural sector, inexpensive, easy to prepare, and environmentally friendly. These findings also may be useful for future study aimed at improving FFJ.

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