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Original Paper

Effect of coconut husk organic fertilizer from liquid organic fertilizer waste on growth and yield eggplant (*Solanum melongena* L.)

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The objective of the study was to determine the effect of using coconut husk organic fertilizer from liquid organic fertilizer waste on the growth and yield of eggplant. The factors of the experiment were; P_0 = 0 t/ha coconut husk organic fertilizer from liquid organic fertilizer waste, P_1 = 7 t/ha coconut husk organic fertilizer from liquid organic fertilizer waste, P_2 = 14 t/ha coconut husk organic fertilizer from liquid organic fertilizer waste, P_3 = 21 t/ha coconut husk organic fertilizer from liquid organic fertilizer waste arrange as a randomized block design factorial. The results show that the doses of coconut husk organic fertilizer from liquid organic fertilizer waste 21 t/ha gives a higher fruit weight of 69.97 t/ha. The lowest result is without the provision of coconut husk organic fertilizer from liquid organic fertilizer waste with a weight of 52.87 t/ha. In addition, there is a significant relationship between the rate of plant growth and the rate of net assimilation (r = 0.90**) and the weight of fruit weight per hectare (r = 0.51**). This study revealed that the application of coconut husk organic fertilizer from liquid organic fertilizer waste at high doses could increase the growth and yield of eggplant.

Keywords: coconut husk, eggplant, organic fertilizer waste, yield

1 Introduction

Eggplant is part of Solanaceae family and commonly cultivated in many parts of the world. Biotic and abiotic components of an ecosystem could easily harm the plants. Therefore, it is necessary to change its varieties with resistance to disease, pests, and adaptability to climate change (Saini and Kaushi, 2019). In line with the population growth, the demand for eggplant also continues to increase, but the increase in demand is not accompanied by an increase in the amount of production, one of which is due to the low productivity of eggplant. Proper fertilization can be done in order to enhance eggplant yield. Fertilization is important for optimizing plant growth and yield by taking the efficiency of nutrient use into account (Souza et al., 2018). According to Oliveira et al. (2014) wrong fertilization management leads to ground water contamination.

Apart from having a function as a soil repairer to provide nutrients, organic fertilizers also play a role in improving the physical and biological characteristic of soil. Coconut husk is one of the sources of organic fertilizer that can be used as compost. The addition of organic materials is very helpful in repairing degraded soil, as the use of organic fertilizers can bind nutrients that are easily lost and help to provide soil nutrients so that fertilization efficiency is higher. Soil organic matter is considered as the basis for plant productivity in organically managed agricultural systems, but for farmers there are still few indicators to assess soil organic matter and soil fertility status (Hidayanto et al., 2020). Soaked coconut husk organic fertilizer from liquid organic fertilizer waste will have a negative impact on the environment if it is left unused. Physical and chemical research results of coconut husk have a bulk density of 0.15 g/cm^3, water holding capacity of 624.31%, and nutrient content of N, P, K, Ca, Mg, Fe, Mn, and Zn (Ravindranath, 1991).

Coconut husk organic fertilizer from liquid organic fertilizer waste has been initially given an immersion treatment to be used as liquid organic fertilizer. To take advantage of the solid waste generated from the

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manufacture of liquid organic fertilizer soaked in coconut husks, composting is necessary so that the nutrients are available and easily absorbed by plants. A combination between the use of coconut husk organic fertilizer from liquid organic fertilizer waste with inorganic fertilizers can to create well-maintained soil chemical physics quality and increase plant productivity. Therefore, this study aimed to determine the effect of using coconut husk organic fertilizer from liquid organic fertilizer waste on the growth and yield of eggplant.

2 Material and methods

The research was conducted at Tembokrejo, Purworejo District, Pasuruan City with a height of ±5 m asl in April to August 2020. The tools used include compost making tools, caliper, soil processing tools, analytical balance, and oven. The materials used include green eggplant seed varieties Milano F1, coconut husk organic fertilizer from liquid organic fertilizer waste, goat manure, Effective Microorganism 4 (EM4), molasses, urea, Zwavelzure Ammoniac (ZA), fostifor, and KCl fertilizer.

The fertilizers applied are only liquid organic fertilizer waste, goat manure, urea, ZA phosphorous and KCl while EM4 and molasses are used to make coconut husk organic fertilizer from liquid organic fertilizer waste. The chemical composition of the fertilizer used is Urea (46% N), ZA (21% N), KCl (45%), while coconut husk organic fertilizer from liquid organic fertilizer waste is Total N : 1.39%; P_2O_5 : 0.53%; K_2O : 1.95%. Fertilizer application is carried out by pouring it around the plants at the age of 7, 14, 21 and 28 DAT (days after transplanting)

The study used a randomized block design with four treatments that were repeated six times, with the following treatments: P_0 = 0 t/ha coconut husk organic fertilizer from liquid organic fertilizer waste, P_1 = 7 t/ha coconut husk organic fertilizer from liquid organic fertilizer waste, P_2 = 14 t/ha coconut husk organic fertilizer from liquid organic fertilizer waste, P_3 = 21 t/ha coconut husk organic fertilizer from liquid organic fertilizer waste. Observations consisted of leaf area (LA), leaf area index (LAI), net assimilation rate (NAR), crop growth rate (CGR), and fruit weight per hectare observed when the plants were harvested. The single pot size is 350 × 320 cm, then the number of plants/plot is 49 plants and the row distance and distance within the row is 50 × 40 cm.

Transplantation is carried out when the plant is about one month old after sowing, when the plant has 4 or 5 leaves, and harvest is carried out every 4 days starting at the age of 50–83 DAT on all fruit. Characteristics of fruit ready to harvest are as follows: fruit shape oval, the green color is a bit faded and the eggplant meat is not yet hard.

Based on the leaf area calculated using grid or graph paper technique, the leaf area of the eggplant was related to variable leaf dimension (Singh et al., 2018).

$$LA = 0.00409\left[192.68\left(\frac{LL}{100}\right)\cdot\left(\frac{LW}{100}\right)-1\right] \quad (1)$$

where: LA – leaf area (cm^2); LL – leaf length (cm); LW – leaf width (cm)

The leaf area index (LAI) of eggplant was modeled into a linear relationship with the plant height as indicated by equation 2 (Singh et al., 2018):

$$LAI = 0.021\left[31.48\left(\frac{h}{100}\right)-1\right] \quad (2)$$

where: h – plant height (m)

The NAR were calculated by the following formulas (Redford, 1967):

$$NAR = \frac{W_2 - W_1 \cdot \log_e A_2 - \log_e A_1}{A_2 - A_1 \cdot t_2 - t_1} \quad (3)$$

where: W_2 and W_1 – total dry matter (g) at successive stages; t_2 and t_1 – time interval (day); loge A_2 and loge A_1 – natural log differences in leaf area

Meanwhile, to calculate CGR using the formula from Egli and Zhen-we (1991):

$$CGR = \frac{1}{GA}\cdot\frac{W_2 - W_1}{t_2 - t_1} \quad (4)$$

where: GA – ground area (m^2)

Yield measurement was carried out by weighing the total yield of plot fruit which was then converted into tons of hectares. The formula used is as follows:

$$fruit\ weight/\text{ha} = \frac{area/\text{ha}}{area/plot}\cdot fruit\ weight/plot \quad (5)$$

Statistical data interpretation was analyzed by Least Significance Different (LSD) Test and by Pearson's correlation using the IBM SPSS Statistics version 25 (US).

3 Results and discussion

3.1 Leaf area

Leaves are the main organ in plants that serve as a place for the photosynthesis process to occur. The ability of plants to carry out photosynthesis is largely determined by the leaf area of the plant. At the age of 31 Day After Transplanting (DAT) observations, the leaf area of the eggplant plant showed that the doses of coconut husk

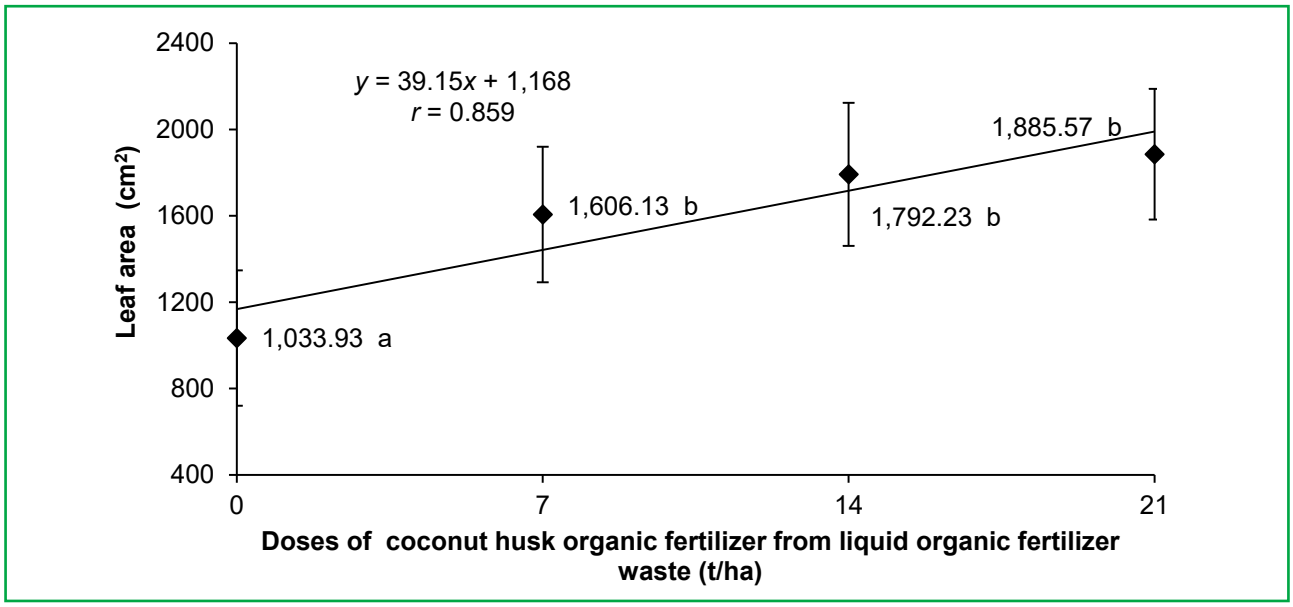

Figure 1 Leaf area with differents organic fertilizer doses
Error bars represent standard deviation. Arrow of the continuous and dotted lines show the trend between doses of organic fertilizer with leaf area. Mean followed by the same letter was not significantly different based on the LSD test at a significance level of 5%

organic fertilizer from liquid organic fertilizer waste 21 t/ha, was not significantly different from the doses of coconut husk organic fertilizer from liquid organic fertilizer waste 14 t/ha and 7 t/ha. Nevertheless, the doses of coconut fiber organic fertilizer from liquid organic fertilizer waste of 21 t/ha produced the highest leaf area of 1,885.57 cm^2 (Figure 1). This is according to the results of research by Singh et al. (2018) because the greater the number of leaves produced, the higher the value of the leaf area of a plant.

The expansion in leaf area indicates the ability to receive and absorbing sunlight more optimally so that the result of photosynthesis can be high. In line with the research of Pratiwi and Maghfoer (2019), in order to increase leaf area, it is important to add large doses of organic fertilizer so it could surge a number of leaves, photosynthesis, and cell extension.

3.2 Leaf area index

Leaf area index (LAI) is defined as half of the total green leaf area per unit horizontal surface area (Chen and Black, 1992). LAI is one of the most important parameters characterizing the structure, process and function of the plant canopy. LAI correlates with photosynthesis, respiration and transpiration of plant canopy which results in the exchange of matter and energy between ecosystem and atmosphere (Bréda, 2003). At the age of 31 DAT observations, the highest leaf area index was in P_3 treatment. This is because the more the number of leaves produced, the higher the leaf area, resulting in the highest LAI value of 0.94 cm^2.

The increase in LAI based on the Table 1 still shows a value of less than 1, according to Sitompul and Guritno (1995), the Leaf Area Index value <1 describes the leaves that are not mutually shaded. Leaf area index as believed by Yoshida (1981), is influenced by leaf distribution and

Table 1 Leaf area, leaf area index, net assimilation rate, plant growth rate at the age of 31 DAT and fruit weight per hectare*

Doses of organic fertilizer coconut husk	Leaf area indeks (cm^2)	Net assimilation rate (g/dm^2/week)	Crop growth rate (g/ m^2/d)	Fruit weight per hectare (t)
P_0 (0 t/ha)	0.52 a	0.0011 a	0.0037 a	52.87 a
P_1 (7 t/ha)	0.80 b	0.0012 a	0.0061 ab	55.79 a
P_2 (14 t/ha)	0.90 b	0.0013 a	0.0071 b	59.76 ab
P_3 (21 t/ha)	0.94 b	0.0013 a	0.0081 b	69.97 b
LSD 5%	0.24	tn	0.0027	11.91

* means followed by the same letters in the same column are not significally different according to LSD test at p <0.005

density which is closely related to plant population or spacing. The highest leaf area results in the treatment of coconut husk organic fertilizer from liquid organic fertilizer waste 21 tons/ha was directly proportional to the Leaf Area Index (Table 1). According to Yoshida (1981), the wider the leaf, the higher the rate of photosynthesis so that it will produce a high leaf area index value.

3.3 Net assimilation rate

According to Shipley (2006), the net assimilation rate is the net result of assimilation and most of the photosynthesis results per unit area and per unit time is influenced by the amount of solar radiation, leaf area index and the number of plant respiration. Meanwhile, according to Poorter and Nagel (2000) NAR was the most important predictor of relative growth rates in various species of wood and grass. In addition, according to Tesar (1984), stated that the rate of net assimilation rate is strongly influenced by the spread of sunlight on the plant canopy, the presence of leaves that shade each other will reduce the rate of net assimilation.

All treatments did not show a significant effect on the net assimilation rate but the highest results were P_2 and P_3 treatments of 0.0013 and the lowest treatment P_0 of 0.0011 (Table 1). This is because the LAI value <1 in all treatments means that the plants do not shade each other and the LAI of the treatment is not significantly different so that the ability of each treatment to absorb light is the same and produces a NAR value that is not significantly different.

3.4 Crop growth rate

Treatment of coconut husk organic fertilizer from liquid organic fertilizer waste showed the highest plant growth rate in the treatment dose of coconut husk organic fertilizer from liquid organic fertilizer waste 21 t/ha of 0.0081 (Figure 2). This shows that the doses of coconut husk organic fertilizer from liquid organic fertilizer waste is 21 t/ha supports vegetative growth such as plant height and leaf number.

Turnbull et al. (2012) stated that experiments to estimate the Crop Growth Rate (CGR) usually plant crops for a certain period of time. Therefore, CGR is calculated on the plant's ability to produce dry matter as a result of assimilation per unit of land area per unit time (g/m^2/week). The growth rate of plants depends on the efficiency of their radiation use, that is, the amount of photosynthetic active radiation intercepted and the efficiency of plants to convert the intercepted photosynthetic active radiation into biomass above ground level (Cirilo et al., 2009). The greater the value of the crop growth rate, the greater the efficiency of the formation of plant biomass. The improvement in plant growth is indicated by an increase in the number of leaves in line with the increase in leaf area value, the higher the leaf area results in an escalating LAI value followed by a rising in NAR and CGR (Figure 3).

3.5 Fruit weight per hectare

Coconut husk organic fertilizer from liquid organic fertilizer waste treatment had a significant effect on eggplant weight. The 21 t/ha treatment had a better

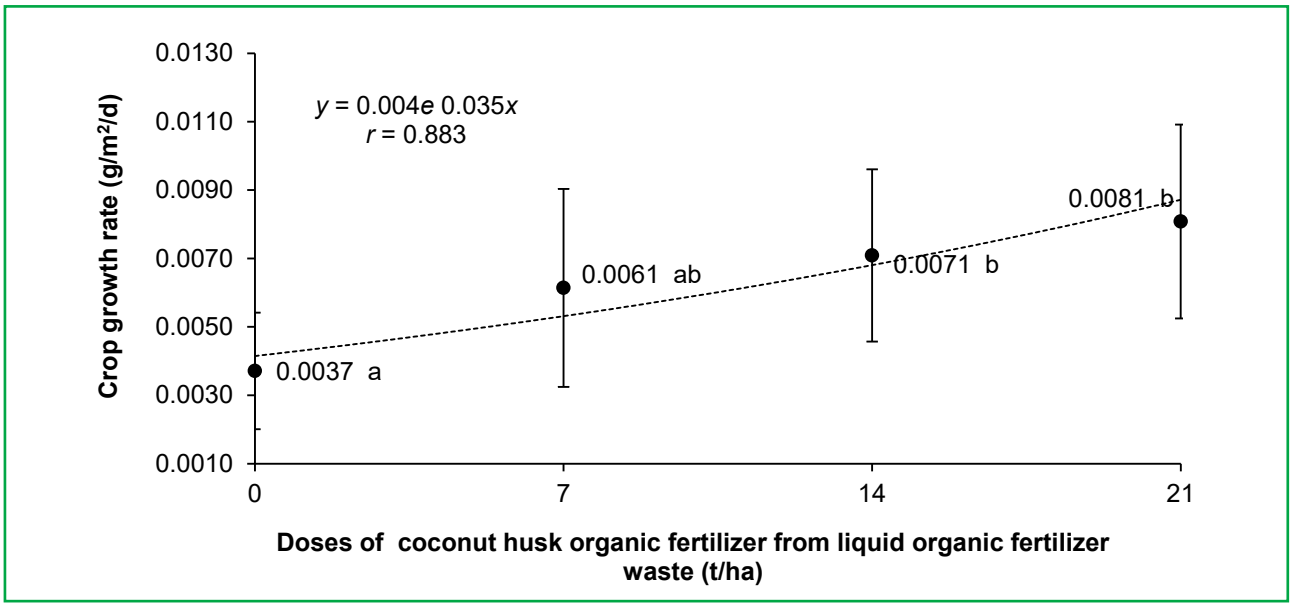

Figure 2 Crop Growth Rate with differents organic fertilizer doses
Error bars represent standard deviation. Arrow of the continuous and dotted lines show the trend between doses of organic fertilizer with Leaf Area. Mean followed by the same letter was not significantly different based on the LSD test at a significance level of 5%

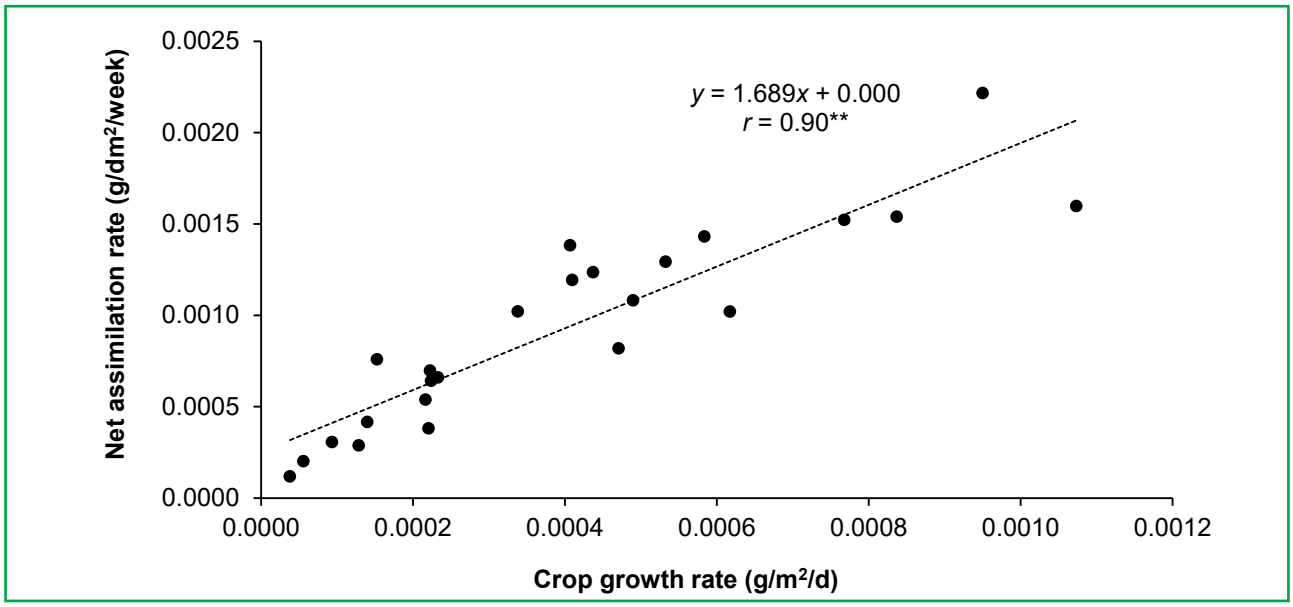

Figure 3 Relationship between NAR with CGR in eggplant land with different organic fertilizer doses

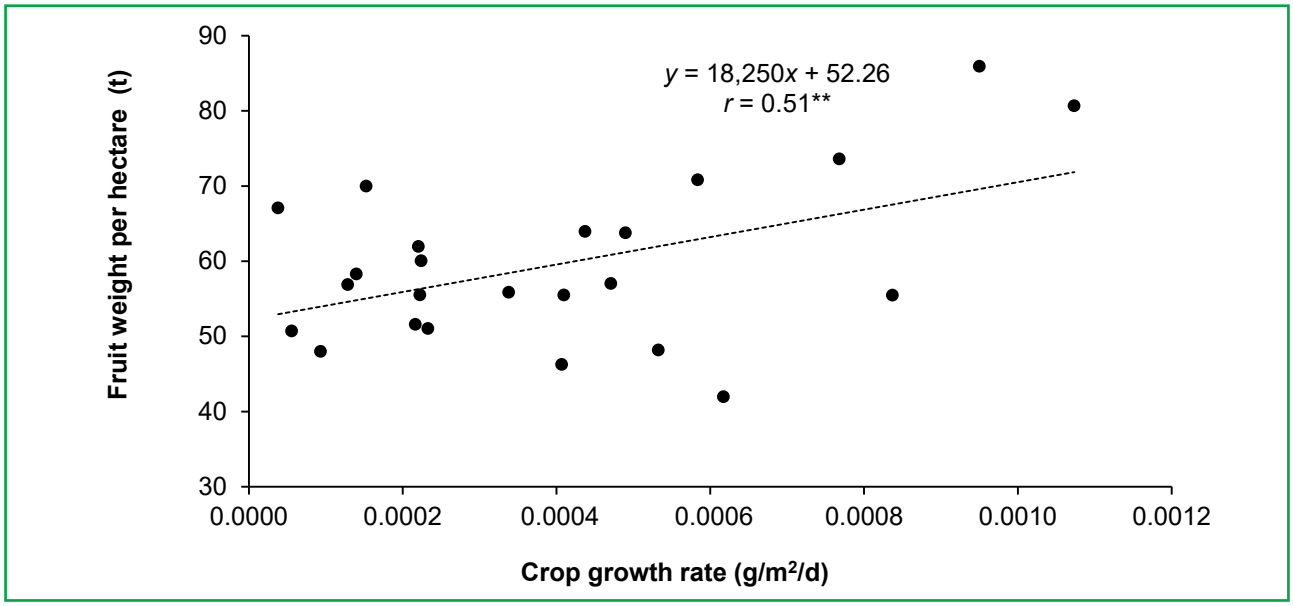

Figure 4 Relationship between Fruit Weight per hectare with CGR in eggplant land with different organic fertilizer doses

results than other treatments during observation of fruit weight per hectare (Table 1). There is a significant correlation ($r = 0.51^{**}$) which indicates that development in the rate of plant growth will be followed by an increase of crops (Figure 4).

The addition of coconut husk organic fertilizer from liquid organic fertilizer waste to the soil can improve nutrient availability for plants,as claimed by Joshi et al. (2013) composting from coconut husk can convert plant nutrients into available forms. In addition, there areother elements such as nitrogen (N) 1.24%, calcium (Ca) 0.5%, magnesium (Mg) 0.48%, carbon (C) 24% and phosphorus (P) 0.06%. When soaked coconut husk is added with molasses, it can be a potential source to produce liquid biological fertilizer. As mentioned by Darmawan et al. (2018) the combination of *Aspergillus niger*, *Pseudomonas putida*, *Bacillus mucilagenosus*, *Azetobacter chrococum* and mixed culture isolated from Lapindo mudflow has been found to be a promising combination to make organic liquid fertilizer for chili, tomato, eggplant, and manure.

In addition, plant growth occurs due to the processes of cell division and cell elongation, where these processes require large amounts of carbohydrates. The cell

elongation rate clearly influences overall plant height since cell division is restricted to a small portion of the shoots and roots (Sussman and Haruta, 2017). The availability of sufficient nutrients in eggplant plants produces a high yield on the treatment of coconut husk organic fertilizer from liquid organic fertilizer waste 21 t/ha.

4 Conclusions

Based on the research results, adding coconut husk organic fertilizer from liquid organic fertilizer waste show a great impact on the yield of eggplant. The doses of coconut husk organic fertilizer from liquid organic fertilizer waste of 21 t/ha gave a higher fruit weight, which was 69.97 t/ha and followed by the doses of coconut husk organic fertilizer from liquid organic fertilizer waste 14 t/ha of 59.76 t/ha. The lowest yield is controlled treatment (P_0) with a weight of 52.87 t/ha. In addition, there is a significant relationship between the rate of plant growth and the rate of net assimilation (r = 0.90**) and the weight of fruit weight per hectare (r = 0.51**), so that the addition of fertilizer with high doses can produce high fruit weights.

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