Effect of Four Organic Liquid Wastes on The Growth of Four Trichoderma Harzianum Isolates and Their Effect on Cucumber Growth and Yield

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Pengaruh Empat Limbah Cair Organik Terhadap Pertumbuhan Empat Isolat *Trichoderma Harzianum* Serta Pengaruhnya Terhadap Pertumbuhan dan Hasil Mentimun

Effect of Four Organic Liquid Wastes on The Growth of Four *Trichoderma Harzianum* Isolates and Their Effect on Cucumber Growth and Yield

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh limbah cair organik empat terhadap pertumbuhan empat isolat Trichoderma harzianum serta pengaruhnya terhadap pertumbuhan dan hasil mentimun. Rancangan acak kelompok digunakan dengan 20 perlakuan dan 3 ulangan. Perlakuan terdiri atas kontrol, limbah cair tahu, air cucian beras, air kelapa, dan limbah cair tapioka yang masing-masing dikombinasikan dengan empat isolat T. harzianum. Variabel yang diamati adalah kerapatan konidium selama dekomposisi, kerapatan akhir konidium, tinggi tanaman, panjang akar, bobot segar dan kering akar, bobot segar dan kering tanaman, pembungaan pertama, jumlah buah per tanaman, dan bobot buah. Hasil penelitian menunjukkan bahwa pada limbah cair tapioka hanya isolat T16 yang mampu tumbuh dengan baik dengan kerapatan maksimum 6,70x107 konidium/mL. Pada limbah air cucian beras, pertumbuhan konidium isolat T16 lebih baik dibandingkan limbah air kelapa dengan kerapatan maksimum $6{,}25x10^7$ konidium/mL. Limbah cair organik terbaik untuk media tanam T. harzianum adalah limbah cair tahu. Pada hari ke-4 dengan limbah cair tahu, isolat T16 dapat mencapai kerapatan konidium sebesar $1{,}12x10^8$ konidium/mL. Limbah cair organik hasil dekomposisi T. harzianum tidak berbeda dengan hasil mentimun.

ABSTRACT

The aim of this research was to determine the effect of four organic liquid wastes on the growth of four Trichoderma harzianum isolates and their effect on cucumber growth and yield. Randomized block design was used with 20 treatments and 3 replicates. The treatments consisted of control, tofu liquid waste, rice washing water, coconut water, and tapioca liquid waste each combined with four T. harzianum isolates. Variables observed were conidia density during decomposition, conidia late density, crop height, root length, root fresh and dry weight, crop fresh and dry weight, the first flowering, number of fruits per plant, and fruit weight. Result of the research showed that in the tapioca liquid waste, only T16 isolates was able to grow well with a maximum density of 6,70x10^{7} *conidia/mL. In the rice washing water, conidia growth of the isolate was better than coconut water with a maximum density of 6,25x10*^{7} *conidia/mL. The best organic liquid waste for growing media of T. harzianum was tofu liquid waste. On the 4th day with the tofu liquid waste, T16 isolate could achieve conidia density of 1,12x10*^{8} *conidia/mL. The organic liquid waste resulted from T. harzianum decomposition was not different on cucumber yield.*

INTRODUCTION

The genus Trichoderma is a soil-borne antagonist that has been widely studied and used to combat plant diseases (Srivastava et al., 2015; Poveda et al., 2020). Many plant diseases can be controlled with these antagonists using multiple inhibition mechanisms, including competing for nutrients and space, modifying the environmental conditions, and promoting plant growth and plant-defensive mechanisms, antibiosis, and mycoparasitism (Naher et al., 2014; Chen et al., 2016; Zin and Badaluddin, 2020). In addition, the genus Trichoderma. besides controlling plant pathogens, it also has other benefits. It also supports plant growth through several growth hormones (Martínez-Medina et al., 2014) and acts as an organic decomposer (Oktafiyanto et al., 2020; Thaha et al., 2020).

For exploration and preparation of Trichoderma spp., there are still synthetic media for mass proliferation in the lab (Gómez-Mendoza et al., 2014). This condition is inefficient in terms of cost and impractical when mass-produced and applied to farmers. On the other hand, since the role of Trichoderma spp. is so important in overcoming some plant diseases, the presence of these obstacles is a breakthrough in the production of Trichoderma spp. growth media to find cheap and readily available materials (Onilude et al., 2012).

The agricultural processing industry produces waste as a by-product of either liquid or solid waste. This upsets the balance between environmental sustainability and ecosystems if not properly managed. This means that the waste produced is treated before it is released into the environment (Naidoo and Olaniran, 2014). Waste that is continuously disposed of without maximum control can lead to imbalances in the environment (Ferronato and Torretta, 2019). In biological systems, microorganisms use waste to synthesize new cellular materials and provide energy for their synthesis. This is because the waste contains some nutrients needed for the growth and development of microorganisms (Salama et al., 2017).

In this study, several organic liquid wastes were tested on the growth of four isolates of T. harzianum on cucumber plants. Exploration and identification of antagonistic fungi have found four isolates of the fungus T. harzianum, which have the potential to control plant diseases (Soesanto et al., 2013). The purpose of this study was to determine the effect of organic liquid waste on the development of four T. harzianum isolates and the effect of giving organic liquid waste as a result of composting by T. harzianum on the growth and yield of cucumber.

MATERIALS AND METHOD

This research was conducted at the Laboratory of Plant Protection and experimental farm, Faculty of Agriculture, Jenderal Sudirman University, Purwokerto for 4 months.

Preparation of Trichoderma harzainum Isolate

The isolate of T. harzianum used was the result of exploration from the rhizosphere of ginger (T10), pineapple (T14), banana Y16), and shallot (T213). Each isolate was propagated using PDA in a Petri dish aseptically and incubated for seven days or until the mycelium filled the Petri dish and was ready for use at room temperature (Bunbury-Blanchette and Walker, 2019).

Preparation of organic liquid waste

Four types of organic liquid waste (tofu liquid waste, rice washing water, coconut water, and tapioca liquid waste) were obtained from each home industry. All organic liquid waste was filtered and put into an Erlenmeyer flask and then sterilized using an autoclave at 121 C for 30 minutes. Furthermore, the liquid waste is cooled and ready to be used for the next activity.

Propagation of Trichoderma harzianum isolates

Each of the four isolates of T. harzianum was propagated in every four types of sterile organic liquid waste by adding 2 cork drill bits (diameter 1.0 cm) to each erlenmeyer containing 100 mL of waste. Furthermore, the waste is shaken (Daiki Orbital) at a speed of 135 rpm for 7 days at room temperature. Conidia density of T. harzianum counted at the end of shaking using a haematocytometer.

Research design

The research used a randomized block design with 20 treatments and 3 replications. The treatments tried included control of tofu liquid waste, rice washing water, coconut water, and tapioca liquid waste, T. harzianum T10, T213, T14, and T16 isolates in tofu liquid waste, T. harzianum T10, T213, T14, and T16 isolates in rice washing water, T. harzianum T10, T213, T14, and T16 isolates in coconut water, and T. harzianum T10, T213, T14, and T16 isolates in tapioca liquid waste.

Treatment application

Application of treatment is done by spraying T. harzianum as much as 100 ml/plant two days before planting. Application is only done once before the cucumber seeds are planted.

Variables observed

The components of composting observed were conidia density by counting conidia using a haemocytometer. Other components observed were the temperature and pH of the substrate. The growth components observed included plant height, root length, fresh root weight, dry root weight, fresh plant weight, dry plant weight. The yield components observed included the time of first flowering, number of fruit per plant, fresh fruit weight, and volume per fruit. In addition, soil pH, temperature, and moisture were also measured.

Data analysis

Data were analyzed using the F test at an error rate of 5%. If there is a significant difference, a further test is carried out using DMRT at an error rate of 5%.

RESULT AND DISCUSSION

A. Effect of Organic Liquid Waste on the Growth of Trichoderma harzianum

1. Waste pH

The initial pH of tofu liquid waste, rice washing water, coconut water, and tapioca liquid waste were 4.3, 4.3, 4.0, and 4.2, respectively. The fourth pH of the waste is a pH that is in an acid indicator. These conditions are suitable for the growth and development of soil fungi, especially T. harzianum. In accordance with the statement of Trushina et al. (2013) and Singh et al. (2014), Trichoderma sp. more suitable to grow in medium with acidic pH conditions. Low pH conditions will affect the life of Trichoderma sp. to demonstrate its ability to overcome plant pathogens (Naher et al., 2014).

2. Waste temperature

The initial temperatures of tofu liquid waste, rice washing water, coconut water, and tapioca liquid waste were 31, 30, 30.5, and 30 ^{O}C. During composting, the temperature is relatively stable with changes in temperature degrees that are not too far from the initial temperature of the waste. The final temperatures of liquid organic waste showed a decrease but not too much, namely the temperatures of tofu liquid waste, rice washing water, coconut water, and tapioca liquid waste were 30-30.5, 29, 29-30, and 29 ^{O}C, respectively. The temperature during the composting is the optimum temperature for the development of Trichoderma sp. In accordance with the statement Singh et al. (2014), temperature of 25-30 ^{O}C is the best temperature for the development of Trichoderma sp.

3. Conidia density

The highest late conidia density of T. harzianum was application in coconut water and T. harzianum T213 of 6.20 × 105 cfu g-1 soils (Table 1). The high density is thought to be due to nutritional and environmental factors that support the growth of T. harzianum. Matin et al. (2019), stated that the use of a medium that contains a lot of organic matter is one of the factors for the development of T. harzianum. Singh et al. (2014) added that T. harzianum conidia germinated well at 70% humidity and optimum growth occurred at 30 ^{O}C. The lowest density was the application of rice washing water and T. harzianum T16 at 8.00 × 104 cfu g-1 soils. The low density may be caused by reduced nutrient sources. Nutrient sources used by T. harzianum were plant root exudates and liquid organic substrates (Zhang et al., 2014; Lombardi et al., 2018). Plant roots secrete several compounds, such as amino acids, vitamins, sugars, amino acid tannins, organic acids, fatty acids, and sterols (Hassan et al., 2019). These compounds are also present in organic liquid substrates, but may be available in small quantities in the soil due to decomposition for the growth of Trichoderma sp. the. In general, the final density of T. harzianum in the soil decreased in all applications, with decreases ranging from 47.02-780.25 % (Table 1). This is presumably due to differences in the growing environment of T. harzianum, so it requires the ability to adapt. Adaptation will cause changes in the viability of T. harzianum so that some T. harzianum conidia die (Es-Soufi et al., 2017). In addition, the decrease in the density of T. harzianum in the soil after application was also caused by the reduced presence of nutrients in the soil. This is because the application is done two days before the seeds are planted, so the nutrients will be washed away or lost to evaporate. T. harzianum needs to colonize the root (Poveda et al., 2019).

Tabel 1. Penghitungan kepadatan konidium *T. Harzianum*
Table 1. Calculation of conidium density of T. Harzianum

Treatments	Early conidia density ($\times 10^6$ conidia mL^{-1})	Late conidia density (cfu g^{-1} of soil)	Decrease (%)
Tofu liquid waste + *T. harzianum* T10	53.40	2.0×10^5	266
Tofu liquid waste + *T. harzianum* T213	48.78	4.2×10^5	115
Tofu liquid waste + *T. harzianum* T14	47.80	2.4×10^5	198.16
Tofu liquid waste + *T. harzianum* T16	63.00	4.2×10^5	149
Rice washing water + *T. harzianum* T10	56.00	2.0×10^5	279
Rice washing water + *T. harzianum* T213	58.10	4.4×10^5	131.04
Rice washing water + *T. harzianum* T14	57.30	3.6×10^5	158.16
Rice washing water + *T. harzianum* T16	62.50	8.0×10^4	780.25
Coconut water + *T. harzianum* T10	28.20	3.8×10^5	73.21
Coconut water + *T. harzianum* T213	29.80	6.2×10^5	47.06
Coconut water + *T. harzianum* T14	49.80	1.6×10^5	310.25
Coconut water + *T. harzianum* T16	60.70	1.2×10^5	504.83
Tapioca liquid waste + *T. harzianum* T10	4.19	5.6×10^5	6.48
Tapioca liquid waste + *T. harzianum* T213	3.01	4.4×10^5	5.84
Tapioca liquid waste + *T. harzianum* T14	3.21	2.0×10^5	15.05
Tapioca liquid waste + *T. harzianum* T16	60.70	5.6×10^5	107.39

B. Effect of Trichoderma harzianum in Liquid Formula on Cucumber Plant Growth

1. Crop height

The significant effect on plant height from the treatment of the four T. harzianum isolates showed that T. harzianum was able to support plant growth during the vegetative phase (Table 2). In this condition, it is suspected that T. harzianum produces hormone compounds in its secondary metabolites, which stimulate the growth of cucumber plants. This agrees with Li et al. (2015) that T. harzianum is able to increase plant growth, increase the absorption of active minerals and other nutrients from the soil. Cucumber plant height in tofu liquid waste and T. harzianum T10 applications was 220.8 cm higher than all combined applications or an increase of 4.77%. However, the control (tofu liquid waste) was able to equalize the plant height when compared with the treatment of T. harzianum on other substrates, namely the application of rice washing water and T. harzianum T213 of 216.66 cm, coconut water and T. harzianum T213 of 219.16 cm, and tapioca and T. harzianum T16 liquid waste of 216.16 cm. Besides being determined by genetic factors, plant height is also influenced by environmental factors, especially nutrients in the soil (Puhup et al., 2021). The applied effluent contains the nutrients needed by plants to grow. Meanwhile, the presence of T. harzianum in the soil will accelerate the decomposition of organic nutrients into compounds that are easily absorbed by plants (Zin et al., 2020).

Tabel 2. Pengaruh perlakuan terhadap komponen pertumbuhan

Table 2. Effect of treatments on growth component

Treatment	Crop length (cm)	Crop fresh weight (g)	Crop dry weight (g)	Root fresh weight (g)	Root dry weight (g)	Rooth length (cm)	Number of leaves
Control (tofu liquid waste)	217.8 a	123.3 a	17.33 a	8.16 b	1.07 a	45.00 a	20.66 a
Control (rice washing water)	202.2 abc	103.7 a	16.66 a	12.16 ab	1.40 a	51.33 a	20.33 a
Control (coconut water)	213.0 ab	113.7 a	18.66 a	16.33 ab	1.98 a	56.33 a	20.33 a
Control (tapioca liquid waste)	199.8 abc	103.8 a	16.50 a	15.50 ab	1.80 a	51.16 a	19.00 a
Tofu liquid+*T. harzianum* T10	220.8 a	103.0 a	17.33 a	19.33 ab	2.32 a	45.83 a	17.00 a
Tofu liquid+*T. harzianum* T213	195.7 abc	97.3 a	13.33 a	12.50 ab	1.56 a	52.50 a	19.16 a
Tofu liquid+*T. harzianum* T14	208.8 ab	98.5 a	14.83 a	13.66 ab	1.58 a	49.50 a	19.33 a
Tofu liquid +*T. harzianum* T16	216.7 a	112.3 a	16.83 a	12.50 ab	1.48 a	47.33 a	20.00 a
Rice water + *T. harzianum* T10	183.2 abcd	91.2 a	15.33 a	13.00 ab	1.83 a	52.33 a	19.00 a
Rice water+*T. harzianum* T213	220.7 a	105.0 a	16.66 a	23.33 a	2.75 a	50.50 a	18.66 a
Rice water + *T.*	127.7 d	64.5 a	9.50 a	8.00 b	0.86 a	45.50 a	16.66 a

harzianum T14							
Rice water + *T. harzianum* T16	192.3 abc	107.8 a	16.00 a	13.50 ab	1.78 a	51.50 a	18.33 a
Coco water+*T. harzianum* T10	219.2 a	111.2 a	17.16 a	15.83 ab	1.96 a	52.16 a	20.00 a
Coco water+*T. harzianum* T213	205.3 ab	102.0 a	14.50 a	13.66 ab	1.31 a	43.83 a	19.00 a
Coco water+*T. harzianum* T14	195.0 abc	105.0 a	16.16 a	15.66 ab	1.53 a	48.16 a	18.33 a
Coco water+*T. harzianum* T16	152.0 bcd	71.0 a	10.83 a	10.83 b	1.11 a	45.33 a	16.66 a
Tapioca liq.+*T. harzianum* T10	187.5 abcd	91.5 a	14.50 a	13.83 ab	1.52 a	50.83 a	19.00 a
Tapioca liq.+*T. harzianum* T213	186.8 abcd	94.8 a	14.50 a	15.00 ab	1.45 a	53.83 a	19.33 a
Tapioca liq.+*T. harzianum* T14	142.5 cd	75.5 a	11.83 a	9.16 b	1.09 a	42.00 a	17.33 a
Tapioca liq.+*T. harzianum* T16	216.2 a	113.2 a	17.50 a	14.00 ab	1.38 a	56.00 a	20.00 a

Note: Numbers followed by the same letter notation in the same column were not significantly different according to DMRT with a level of 5%.

2. Root fresh weight

The results of the analysis on root fresh weight showed that the application of T. harzianum had a significant effect on increasing root fresh weight (Table 2). This was shown in the application of rice washing water and T. harzianum T213 had the highest root fresh weight of 23.3 g when compared to other combination treatments and control, an increase of 3.21%. In the control of tofu liquid waste, the plants had a fresh root weight of 8.2 g or the lowest compared to other control plants. The highest root fresh weight was applied to rice washing water and T. harzianum T213, and was in line with plant height. The increase in fresh root weight was thought to be due to the enzyme released by T. harzianum which was able to stimulate root growth. In accordance with the statement of Alfiky and Weisskopf (2021), T. harzianum can stimulate the formation of lateral roots, because it secretes an active substance such as the hormone auxin which stimulates the formation of lateral roots. Root extension will encourage an increase in the wet weight and dry weight of the roots which results in better plant growth, and ultimately results in increased yields (Shrivastava and Kumar, 2015).

3.Plant fresh weight, plant dry weight, root dry weight, root length, and number of leaves

The result of the statistical analysis is shown that the treatment of organic liquid waste from T. harzianum composting did not significantly affect the increase in fresh weight of plants, dry weight of plants, dry weight of roots, root length, and number of leaves (Table 2). This is probably due to the fact that the application is done before sowing cucumber seeds and does not support plant growth, so evaporation and leaching also reduce the nutrient content of the soil. This corresponds to the belief that Lee et al. (2017) lack of nutrients in the soil impedes plant growth. In addition, the lack of differences between applications showed all isolates of T. harzianum required additional doses to affect plant growth. This is supported by the statement of Arain et al. (2015) that the higher doses of T. harzianum will improve plant growth.

C. Effect of the Treatment on Cucumber Yield

The results of the statistical analysis showed no significant difference in fruit weight, number of fruits per plant, number of flowers, flowering time, and amount of fruits (Table 3). It is believed that the role of growth-promoting hormones produced by T. harzianum was not optimal. T. harzianum is also known to be able to produce the hormone gibberellin (Pedrero-Méndez et al., 2021). Gibberellin affects plant growth through its effects on cell growth and elongation (Gupta and Chakrabarty, 2013). This is consistent with the fact that there are no major differences in growth factors (Table 2). The yield component of cucumber is also affected by the nutrient content of the soil. Proper nutrition supports plant growth, and high photosynthesis affects plant yields (Guo et al., 2019).

Tabel 3. Pengaruh perlakuan terhadap komponen hasil
Table 3. Effect of treatment on yield component

Treatment	Fruit weight (g)	Number of fruits	Number of flowers	Time of flowering (days)	Fruit volume (mL)
Control (tofu liquid waste)	333.16 a	1.33 a	7.50 a	25 a	335.83 a
Control (rice washing water)	253.33 a	1.50 a	8.00 a	25 a	299.50 a
Control (coconut water)	343.16 a	1.50 a	9.00 a	25 a	341.66 a
Control (tapioca liquid waste)	245.00 a	1.00 a	8.66 a	25 a	230.00 a
Tofu liquid+*T. harzianum* T10	325.66 a	1.16 a	8.66 a	25 a	333.00 a
Tofu liquid+*T. harzianum* T213	212.33 a	1.33 a	8.00 a	25 a	215.83 a
Tofu liquid+*T. harzianum* T14	214.16 a	1.66 a	8.33 a	25 a	212.50 a
Tofu liquid +*T. harzianum* T16	288.66 a	1.16 a	8.50 a	25 a	285.00 a
Rice water + *T. harzianum* T10	228.83 a	1.16 a	11.00 a	25 a	234.16 a
Rice water+*T. harzianum* T213	166.16 a	1.50 a	8.50 a	25 a	269.66 a
Rice water + *T. harzianum* T14	137.66 a	0.66 a	6.83 a	25 a	96.33 a
Rice water +*T. harzianum* T16	251.16 a	1.00 a	8.00 a	25 a	246.16 a
Coco water+*T. harzianum* T10	286.66 a	1.33 a	6.66 a	25 a	246.66 a
Coco water+*T. harzianum* T213	144.66 a	1.00 a	8.16 a	25 a	211.33 a
Coco water+*T. harzianum* T14	211.33 a	1.33 a	8.16 a	25 a	220.00 a
Coco water+*T. harzianum* T16	180.00 a	1.33 a	9.66 a	25 a	187.50 a
Tapioca liq.+*T. harzianum* T10	274.00 a	1.50 a	8.33 a	25 a	272.50 a
Tapioca liq.+*T. harzianum* T213	215.83 a	1.50 a	8.83 a	25 a	214.16 a
Tapioca liq.+*T. harzianum* T14	198.00 a	1.33 a	8.33 a	25 a	186.66 a
Tapioca liq.+*T. harzianum* T16	221.33 a	1.33 a	9.50 a	25 a	220.00 a

Note: Numbers followed by the same letter notation in the same column were not significantly different according to DMRT with a level of 5%.

The ability of *T. harzianum* to produce growth-promoting hormones such as auxin and gibberellins, was not matched by the production of other hormones, namely cytokinins. This is thought to be one of the factors causing the cucumber plants tested with the *T. harzianum* treatment not to be able to increase the yield component. In accordance with the research results of Illescas *et al*. (2021), that *Trichoderma* sp. capable of producing phytohormones, namely gibberellins, abscisic acid, salicylic acid, auxin (indole-3-acetic acid: IAA) and the cytokinins dihydrozeatin, isopenteniladenine and trans-zeatin.

A. Effect of Physical and Chemical Properties of Soil on the Development of *T. harzianum*

1. Soils pH

Soil pH measured in all control plants did not differ from soil pH in plants treated with *T. harzianum*. This proves that the application of organic liquid waste from the composting of *T. harzianum* does not change the soil pH (Table 4). The pH in the soil in all applications corresponds to the pH needed for plants to live and is also suitable *for* the growth of *T. harzianum*. This is in accordance with the opinion Gayal *et al*. (2017) that generally cucumber plants grow at the appropriate pH, namely pH 5.5-6.7. In addition, *T. harzianum* is also able to live at the pH in accordance with Chalimah *et al*. (2020).

Tabel 4. Pengaruh limbah organik cair terhadap karakter fisik tanah
Table 4. Effect of liquid organic waste on soils physic character

Treatment	Average of						
	pH	Temperature (^{O}C)			Relative Humidity (%)		
		Morning	Noon	Afternoon	Morning	Noon	Afternoon
Tofu liquid waste	6.70	27.42	33.53	36.32	68.40	60.13	52.93
Rice washing water	6.74	27.40	34.55	36.77	67.87	57.33	57.00
Coconut water	6.72	27.15	35.75	35.11	70.80	64.80	69.07
Tapioca liquid waste	6.70	28.23	36.31	35.89	69.20	60.07	63.20

2. Soil moisture

Soil moisture in all treatments, both control and *T. harzianum* applications was in between 57–69%. The soil moisture has been able to become a supporting factor for the development of *T. harzianum* in field applications. Loguercio *et al*. (2009) stated that high broom moisture (>30%) and high humidity were required for sporulation of *Trichoderma* spp. In addition, the soil moisture is also needed for roots to grow and develop, so that it can support plant height (Pan *et al*., 2015).

3. Soil temperature

Soil temperature affects the development of the fungus *T. harzianum* in the soil. Soil temperatures that are too high or too low will inhibit the growth of *T. harzianum*. According to Boat *et al*. (2018), the excellent growth rate of *Trichoderma* spp. is found at temperature range of 25–30 ^{O}C with temperatures for growth ranging from 4-35 ^{O}C. The soil temperature observed in each treatment of *T. harzianum* showed an appropriate number to support the growth of the fungus (Table 4). In all *T. harzianum* treatments, the average daily temperature was 27-28 ^{O}C in the morning, 33-36 ^{O}C in the afternoon, and 35-36 ^{O}C in the afternoon.

CONCLUSION

Liquid organic waste used for the growth of T. harzianum gave different growth variations in each isolate. On the 10th day T. harzianum T16 in tapioca liquid waste was able to reach maximum conidia density, while other isolates in the same waste were unable to grow. In rice washing water, the maximum conidia density of T. harzianum T10 was 5.60 × 107 conidia/mL, T. harzianum T14 was 5.26 × 107 conidia/mL, and T. harzianum T213 was 5.23 × 107 conidia/mL. In coconut water, the conidia density of T. harzianum T10 was 2.82 × 107 conidia/mL, T. harzianum T14 was 4.98 × 107 conidia/mL, and T. harzianum T213 was 6.07 × 107 conidia/mL. The best liquid organic waste as a growth medium for T. harzianum is tofu liquid waste. On day 4, T. harzianum T16 was able to reach a density of 1.2 × 107 conidia/mL. Liquid organic waste from the decomposition of T. harzianum did not give different results on the growth and yield of cucumbers.

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