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Research Article

The effectiveness of *Trichoderma koningii* in Improving the quality of Strawberry fruits in Rurukan Plantation, Tomohon

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Abstract

This study aims to obtain a proper application dose of *Trichoderma koningii* to improve the quality of Strawberry fruit. The experiment is conducted in a screen house, at Kina Plantation, Rurukan Village, Eastern Tomohon Subdistrict, Tomohon City. The quality analysis of Strawberry fruit is conducted at the Laboratory of Agricultural Product Technology, Faculty of Agriculture Unsrat Manado. The study is conducted in Complete Random Design, with treatment dose of *T. koningii* in manure and organic potassium (coconut ash), and each treatment is repeated three times, as follows: T0 = 0 g of *T. koningii* / kg of soil; T1 = 0 g of *T.koningii*/kg of soil + 5 tons/ha of Manure + 400 kg/ha of organic P; T2 = 5 g of *T.koningii* / kg of soil + 5 tons/ha of Manure + 400 kg/ha of organic P; T3 = 10 g of *T.koningii* / kg of soil + 5 tons/ha of Manure + 400 kg/ha of organic P; and T4 = 15 g of *T.koningii* / kg of soil + 5 tons/ha of Manure + 400 kg/ha of organic P. Data are obtained by observing and counting the fruit color, fruit texture, sugar and vitamin C content of strawberries. Data are then analyzed by RAL pattern analysis of variance, followed by Duncan test α of 0.05. The results show that the fruit color, fruit texture, sugar and vitamin C content of strawberries are affected by the *T. koningii* dosing. The dose of *T. koningii* is effective on the sugar content of strawberries, where the higher dose of *T. koningii*, the better the sugar content of strawberries.

Keywords: *Trichoderma koningii* , quality, strawberry.

Introduction

Strawberry is one of the fruit plants of temperate regions. This fruits has vitamin C content that is equivalent to oranges and lemons, and contains relatively high iron. The quality, size, texture and color of strawberry fruit are determined by genetic and environmental properties during its growth. The quality improving efforts, especially the taste, still need to be improved such as the selection of cultivars, determination of the growing season and proper fertilization program (Gunawan, 1996). The agriculture system in Tomohon plantations is until now mostly still conventional, where farmers still use synthetic pesticides to control pests that often attack the plantations. By the increasing demand for agricultural products with good quality and quantity, farmers use pesticides for the cultivation of plants from pest attacks without regard to the health aspects of the environment.

The most practical condition improvement of soil fertility is by adding fertilizer to the soil. But the balance of soil fertility must be watched so that the given fertilizer may be effective and efficient. The addition of inorganic fertilizers that provide fast mineral ions alone will damage the soil physical fertility, where the soil becomes hard and compact. Thus, application of organic fertilizer will greatly improve soil conditions. But organic fertilizers are

slower to be decomposed into mineral ions, especially if the application only in the form of addition of raw organic materials only. Therefore the content of the soil microorganisms also needs to be enriched to accelerate decomposition, so that the soil fertility can be maintained.

One of widely known functional microorganisms as soil biological fertilizer is *Trichoderma sp. Trichaderma spp.* has branched conidiophores - regular branch, do not form a beam, ellipse conidium, unicellular, in small groups of terminal, green and blue conidium group (Semangun, 1996). *Trichoderma spp.* is also oval, and have single or group phialid or sterigma (Barnet, 1960 in Nurhaedah, 2002).

Trichoderma species as well as decomposing organisms, can also function as biological agents and plant growth stimulators (Herlina and Dewi, 2010). Some Trichoderma species have been reported as biological agents such as *T. harzianum, T. viridae*, and *T konigii* which have broad spectrum in various agricultural plants. The Trichoderma fungus culture is given to the planting area and serves as biodecomposer, decomposing organic waste (dedaxman debris and old twigs) into quality compost. Also it can serve as biofungicide, which acts to control pathogenic organisms the cause of plant diseases.

Trichoderma can inhibit the growth of several fungi that can cause diseases in plants, e.g. *Rigidiforus lignosus, Fusarium oxysporum, Rhizoctonia solani, Sclerotium* rolfsi. Besides the ability as a biological control, *Trichoderma koningii* gives a positive effect on plant rooting, plant growth, and crop production. These properties also indicate that *T. koningii* acts as *Plant Growth Enhancer*. The tanase enzyme from *T. harzianum* can be used for the production of gallic acid from agro waste and get the cheaper products than without using the enzymes from *T. harzianum* (Iqbal and Kapoor, 2012). It makes the process of production of gallic acid economic and environmentally friendly. In addition, the utilization efficiency of Tanase tannins can also be utilized for a number of industrial applications such as the waste from the processing of tannery, fruit juice, wine, etc. In addition, changes in the absorption of N, P, K, Fe, B, and Mn. The results show the interaction between fertilizing and root inoculation with microorganisms, the effect depends on the genotype, the growth response and the pH of the strawberry plant root environment (Malusa, *et al.,* 2007).

Given the role of *T. koningii* that is very important in maintaining soil fertility and suppressing populations of pathogenic fungi, so that *T. koningii* has potential as an active compost as well as control agents of pathogenic organisms. The provision of *Trichoderma spp.* with a dose of 4 l ha^{-1} can increase the production of local varieties of rice in the Gunttmg Papuyu Village, Gambut District, Banjar Regency from previous production of 3.5 t ha^{-1} of dry grain harvest to 5.04 t ha^{-1} of dry grain harvest (Balittra, 2010). This study is conducted to evaluate the potential of *T. koningii* as active compost which acts in maintaining soil fertility as well as controlling pathogenic organisms that cause plant diseases. The use of active compost *T. koningii* is an alternative to improve soil microbes which will speed up the composting process, keep the fertility of the soil and the microbes will remain alive and active in the compost. When the compost is given to the soil, microbes will act to control pathogenic organisms the cause of plant diseases. The use of active compost *T. koningii* is not been widely applied to strawberry plants and how its application to the quality of strawberry plants. The purpose of this study is to obtain the proper application dose *of T. koningii* to improve the quality of strawberry fruits.

Materials and Methods

Materials and tools

Ingredients: Strawberry seeds, Chicken Manure, II koningii., Distilled water, organic potassium fertilizer which is derived from coconut ash. The results of laboratory analysis of the macro nutrients contained in Coconut ash as a source of potassium. Tools used includes: Green house, hoes, buckets, yells, scales, plastic bag, polybag, analytical balance, oven, and glass and Laboratory equipment.

Research design

The experiment is conducted in a screen house, at Kina Plantation, Rurukan Village, Eastern Tomohon District, Tomohon City. The quality analysis of Strawberry fruit is carried out in the Laboratory of Agricultural Product Technology, Faculty of Agriculture, Unsrat, Manado. The study is conducted

in a Complete Random Design. With treatment dose of *T. koningii* in manure and organic potassium (coconut ash), and each treatment is repeated three times, as follows:

T0 = 0 g of *T. koningii* / kg of soil
T1 = 0 g of *T.koningii*/kg of soil + 5 tons/ha of Manure + 400 kg/ha of organic P
T2 = 5 g of *T.koningii* / kg of soil + 5 tons/ha of Manure + 400 kg/ha of organic P
T3 = 10 g of *T.koningii* / kg of soil + 5 tons/ha of Manure + 400 kg/ha of organic P
T4 = 15 g of *T.koningii* / kg of soil + 5 tons/ha of Manure + 400 kg/ha of organic P

Research Procedures

The preparation of research materials and *screen house*, insulation of *T. koningii* to obtain pure cultures, the multiplication of *T. koningii* on corn rice media with the following stages: corn rice is soaked for about 2 hours, then washed and steamed for 30 minutes using stove. The media is cooled and added with sugar 70% / kg of rice corn and then mixed/blended until smooth. Media is then put into a heat resistant plastic bag of 100 g / plastic bag, then closed using stapler. Media in plastic is sterilized using octoclave with a temperature of 150 ° C for 1 hour, then cooled. After cold, it is inoculated with isolates *of T. koningii* which has been prepared in a plastic bag that is carried in entkase aseptically. Inoculation is done for l0 days at room temperature (27 ° C), after the corn media is filled with fungus *T. koningii*, can be applied to the soil medium according to the treatment. Each treatment is put in a polybag of 10 kg, and planted with strawberry seeds. Observations is conducted during the harvest with the observation parameters are: 1. Fruit color using color chart, 2. Texture fruit, using penetro meters, 3. Sugar content, and 4. Vitamin C content. The data are tested by ANOVA and if it is significantly different, then followed by further testing DMRT.

Results and Discussion

Fruit color

The results of analysis of variance show that the color of strawberries at different concentration levels *of T. koningii* is highly significant in the treatment, the average color of strawberry fruit at various concentrations shown in Table 1 below.

Table 1. The average color of strawberries at various concentrations treatment *T. koningii*

Treatment	On average	Notation
Tl	23.313	a
T0	27.753	b
T2	35.097	c
T4	35.215	c
T3	37.221	c

Description: The numbers followed by the same letter are not significantly different at α 0.05 of Duncan test

The *T. koningii* provision affects the color of strawberries, although the treatments T2, T3 and T4 do not give significant effect. This is presumably due to the species of *Trichoderma spp* is micro-organism decomposer, not in mineralization. In line with the opinion of Mahdianoor (2012) which states that *Trichoderma* species are microorganism decomposer of organic material in the process of decomposition of cellulose and hemi cellulose which is only found in plant tissue, not in the process of mineralization. The provision process of nutrient ions from organic matter for the growth and development of plants is through the process of mineralization. In the process of mineralization, the microorganisms which play more roles is the type of bacteria. At the beginning of the decomposition process in organic, fungi (mushrooms) play significant role, then the next stage (Humification phase), it is actinomecetes and at the final stage (mineralization), it is bacteria which play significant role (Driessen and Soepraptohardjo, 1974 *in* Hanafiah, 2005).

Texture Fruit

The results of analysis of variance show that the textures of strawberries at different concentration levels *of T. koningii* are significantly different for each treatment. The average texture of strawberries at various concentrations is shown in Table 2 below.

Table 2. The average of strawberry texture at various concentrations treatment of *T. koningii.*

Treatment	Average (mm kg $^{-1)}$	Notation
T0	0.100	a
T1	0133	a
T2	0.300	b
T3	0.467	c
T4	0.667	d

Description: Numbers followed by the same letter are not significantly different at α 0.05 of Duncan test.

Table 2 shows that the treatment dose of *T. koningii* provides a significant influence on the texture of strawberry. Based on the observations statistical test, the lowest of 0.100 at T0 and the highest is 0.667 at a dose of T4 dose. The higher the dose rate of *T. koningii* that applied will be followed by an increase in the value of the texture of strawberries. The higher value of fruit texture means the softer the fruit is, this is in accordance with the results of Susanto, *et al.* (2010) in the treatment of Strawberry fruit with irrigation system. The results of this study prove that the higher dose of *T. koningii*, the softer fruit texture will be, thus the shelf.

Sugar content

The results of analysis of variance show that the sugar contents in strawberries at various dose levels of *T. koningii* are significantly different in each treatment. The average of sugar content in strawberries at various dose treatments can be seen in Table 3 below.

Table 3. The average of sugar content in strawberries at different treatment doses *of T. koningii*

Treatment	Average (%)	Notation
T0	6.000	a
Tl	7.900	b
T2	8.833	b
T3	9.333	c
T4	11.000	d

Description: Numbers followed by the same letter are not significantly different at α 0:05 of Duncan test.

Table 3 shows that the treatment dose of *T. koningii* provides a significant influence on the sugar content in strawberries. Based on the observation statistical test, the lowest of 6.000 at T0 concentration and the highest is 11.000 at the dose of T4. The higher dose of *T. koningii* which applied will be followed also by an increase in the value of the sugar content in strawberries. This proves that the higher dose of *T. koningii*, the better the sugar content of the fruit, thus it will be more sweet fruit flavor. The results of the Chliyeh, *et al.* (2014) using *T. harzianum* and AMF have a positive effect on the tomato results, where the quality of the fruit in terms of size and number of fruits increase. Likewise, the studies of Seng (2014) in which the cocoa plant is carried out by spraying with a mixture containing *Tricoderma*, sp. stated that the productivity of cocoa beans increased from 500 kg of dry beans / ha and 198 kg/ha to 698 kg/ha.

The content of vitamin C

Results of analysis of variance shows that the vitamin C content of strawberries is influenced by dose of *T. koningii*, the average content of vitamin C in strawberries at various doses can be seen in Table 4.

Table 4. Average amount of vitamin C content in strawberries at various dose treatment of *T. koningii.*

Treatment	Average (mg / 100g)	Notation
T0	9,107 a	a
T1	26,177 b	b
T2	37,910 c	c
T3	38,660 c	c
T4	40,623 c	c

Description: Numbers followed by the same letter are not significantly different at α 0.05 of Duncan test

Table 4 shows that the treatment dose of *T. koningii* provides a significant influence on the vitamin C content in strawberries, compared with no provision of *T. koningii,* although the treatments T2, T3 and T4 do not give significant effect. Based on the observation statistical test, the lowest of 9,107 at T0 and the highest is 40,623 at the dose of T4. The applied dose of *T. koningii* will affect the vitamin C content of strawberries (dose T2, 'I`3, and T4) compared with no application of *T. koningii* (T0 and T1).

This is in line with the conclusion of the study by Herlina (2009) which states that the dose of *Trichoderma* spp affects the vitamin C content of tomato fruit. The provision of *T. koningii* will cause the transport of nutrients smoother. With sufficient nutrient needs, the metabolic processes in plants will be going well, including the process of photosynthesis to produce carbohydrates that will be decomposed into glucose. Nutrients will spur the process of photosynthesis and will further support the synthesis of vitamin C, because one of the basic compounds for the synthesis of vitamin C is glucose.

Conclusion

1. The fruit color, the fruit texture, sugar and vitamin C content of strawberries are influenced by the dose of *T. koningii*.
2. The dose of *T. koningii* is effective on the sugar content of strawberries, where the higher the dose of T. koningii, the better sugar content in strawberry fruit will be.

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