Pelita Perkebunan 40(1) 2024, 1–11
DOI: 10.22302/iccri.jur.pelitaperkebunan.v40i1.595
ISSN: 0215-0212 / e-ISSN: 2406-9574

Potential of Siam Weed Extract in Combination with *Trichoderma harzianum* to Stimulate Seed Germination of *Coffea arabica*

Misbahul Ania Ningsih[1)], Sulistyani Pancaningtyas[2)], and Mukhamad Su'udi[1)]

[1)]Department of Biology, Faculty of Mathematics and Natural Science, University of Jember, Jl. Kalimantan Tegalboto No. 37, Jember, Indonesia
[2)]Indonesian Coffee and Cocoa Research Institute, Jl. PB Sudirman, No. 90, Jember, Indonesia
[*)]Corresponding author: listya.1606@gmail.com
Received: 1 February 2024 / Accepted: 21 March 2024

Abstract

Arabica coffee (*Coffea arabica*) seeds feature a solid and thick seed shape that obstructs the germination process. Seed germination is an important feature of coffee plant cultivation and significantly impacts the growth and development of the coffee plant. Siam weed (*Chromolaena odorata* L.) has the potential to be used as a growth regulator due to its nutrients and secondary metabolite compounds which can help to accelerate plant growth. The optimal use of organic fertilizer can be achieved by using *Trichoderma harzianum*. This research aimed to determine the effect and optimal concentration of siam weed extract and *T. harzianum* on the germination of Arabica coffee seeds. The research used a factorial completely randomized design in the form of siam weed extract concentrations of 8 ppm and 16 ppm and concentrations of *T. harzianum* of 0.5 g, 1 g, 1.5, and 2 g. The research finding indicated that the siam weed extract 16 ppm + *T. harzianum* extract 0.5 g treatment had the best results in terms of germination, growth rate, growth synchrony, hypocotyl length, and number of leaves on coffee plants. Meanwhile, the siam weed extract 16 ppm + *Trichoderma harzianum* extract 2 g treatment had the highest chlorophyll content.

Keywords: Coffee seed, *Chromolaena odorata*, *Trichoderma harzianum*, coffee germination, chlorophyll content

INTRODUCTION

Coffee is one of the most valuable commodities which is widely cultivated in Indonesia. Coffee plays a significant role in economic well-being and is a valuable export commodity for Indonesia, contributing to the growth of foreign exchange (Junaedi *et al*., 2020). Arabica coffee is considered to be the finest coffee variety known for its exquisite flavor, which is particularly popular among the Indonesian population. Arabica coffee demands a greater premium compared to other varieties (Sitanggang *et al*., 2021). According to the 2023 Indonesian Statistics report from the Central Statistics Agency, Indonesia's coffee production reached 794.8 thousand tons in 2022 (BPS, 2023).

Seed germination plays an important role in coffee plant cultivation and significantly impacts coffee plant development (Sitanggang *et al*., 2021). High-quality coffee seedlings require high-quality coffee seeds. Storage attempts to delay seed germination and maintain usage while preserving the qualities of the seeds. Applying fungicide during storage is an approach to protecting the seeds from fungi (Agustini & Yusya, 2020).

Coffee seeds that have reached the end of their shelf life will lose their viability. The decrease in water content of coffee seeds during storage leads to the deactivation of germination-promoting enzymes. The hard skin of coffee seeds (parchment) is a contributing factor to their low germination rate, resulting in their dormancy. Soaking is a priming technique used to enhance the germination of coffee seeds. The purpose of soaking is to facilitate the penetration of water into the endosperm, hence accelerating germination. Treatment seeds that undergo water-soaking have a higher germination rate in comparison to those without soaking exposure (Suhendra *et al*., 2021).

Breaking dormancy in coffee seeds can also use the phytohormone, namely gibberellin. Gibberellin is one of the plant hormones that regulate plant growth, including seed germination, and the development of flowers, fruit, and seeds (Itoh *et al*., 2008). According to Roychowdhury *et al*. (2012), gibberellin hormone with a concentration of 20 ppm is effective in overcoming dormancy in carnation seeds. This is proven by the fact that carnation seeds treated with 20 ppm produced the best germination percentage (87.46%) compared to other hormones. Giving 20 ppm gibberellin to radish plants also showed significant results on plant height, number and length of leaves, and root length compared to controls (Mishra & Nagaich, 2019). Apart from phytohormones, weed plants can also be used to break dormancy in coffee seeds.

Siam weed (*Chromolaena odorata* L.), also known as *kirinyuh*, contains certain nutrients and growth regulators that promote seed germination. Siam weed can be found easily in various types of habitat, because it has high adaptation and competitive ability, can grow quickly, and can reproduce easily compared to other weeds (Kumolo *et al*., 2011). Siam weed can produce high biomass. At six months old, this species produces biomass of 11.2 tons ha^{-1}, while at 3 years old can produce biomass of 277.7 tons ha^{-1}. Biomass of siam weed contains nutrients such as N 2.65%, P 0.53%, and K 1.9% which can stimulate plant growth (Peniwiratri & Arbiwati, 2021). Based on phytochemical screening tests, weed leaf extracts contain secondary metabolite compounds such as saponins, tannins, flavonoids, alkaloids, and phenolics (Frastika, 2017).

Arabica coffee seeds soaked with 16 ppm of siam weed leaf extract can accelerate germination, simultaneity, and growth speed (Unpublish). According to Damayanti (2013), the application of siam weed stem and leaf extract has a significant effect on the germination of mustard greens. The higher extract concentration increases plant height and root ratio. To optimize the potential of siam weed, in this research siam weed was combined with the fungus *Trichoderma* sp.

Trichoderma sp. is a fungus that promotes plant growth and development and is antagonistic to plant pathogenic fungi (Rizal & Susanti, 2018). The *Trichoderma* sp. fungus has the ability to colonize plant root areas and accelerate the availa-bility of macro and micronutrients in the soil (Isnaini *et al*., 2021). *Trichoderma* sp. has the ability to synthesize cellobiohydrolase enzymes, endoglucanase enzymes, and glucosidase enzymes. These three enzymes work synergistically to convert organic materials into essential nutrients for plant growth (Salma & Gunarto, 1996).

The application of *Trichoderma* sp. increase height and number of leaves in Robusta coffee seedlings (Ali *et al*., 2015). The application of *Trichoderma* sp. at 20 mg $polybag^{-1}$ on cocoa seeds increases height, number of leaves, and stem diameter (Isnaini *et al*., 2021). The application of siam weed extract to the soil enhances biological properties and augments

soil porosity, leading to an increase in the population of the fungus *Trichoderma* sp. (Febriyono *et al*., 2018). The objective of this research was to determine the optimal concentration of a combination of siam weed extracts and *T. harzianum* on the germination of coffee seed.

MATERIALS AND METHODS

This research was carried out at the Biotechnology Laboratory, Indonesian Coffee and Cocoa Research Institute, Jember, Indonesia. The research was conducted in March-December 2023. The research used a completely randomized design factorial with two factors. The first factor was concentration of siam weed leaf extract, namely 8 ppm (C1) and 16 ppm (C2), while the second factor was concentration of *Trichoderma harzianum* extract, namely 0.5 g (T1), 1 g (T2), 1.5 g (T3), and 2 g (T4). The spore density of *T. harzianum* is 5.36 x 10^8 g^{-1}.

Treatment Preparation

Siam weed leaves were taken from the field in the plantation area of the Indonesian Coffee and Cocoa Research Institute and then dried in the oven. The dried leaves are made into powder using a blender. As much 0.8 g and 1.6 g of siam weed leaf powder, each dissolved in 100 ml was prepared for 8 ppm and 16 ppm treatment. *T. harzianum* spores in powder form were weighed at 0.5 g, 1 g, 1.5 g, and 2 g each for 3 repetitions. *T. harzianum* powder that has been weighed is mixed into the siam weed solution and then left at room temperature overnight. The extract formed is then filtered using filter paper. The negative control treatment used distilled water immersion, while the positive control used 20 ppm gibberellin immersion.

Media Preparation

Three replications of each treatment were conducted, Each replication used 30 seeds resulting in a total of 30 experimental units. The coffee seeds used Komasti Arabica coffee that had been preserved for six months. The coffee seeds was immersed in 100 mL solution overnight. The soaked coffee seeds were planted in 20 cm × 30 cm trays filled with moistened sand. Every tray designated for each treatment is packed with a total of 25 seeds. Following the process of germination, the trays were covered with transparent polythene plastics to maintain moisture, while the temperature was maintained at 20-30 ^{0}C.

Observation of Solution pH and Optical Density

The pH of the solution was observed using a pH meter Hanna Instrument HI98107. Optical Density (OD) observations used an E-1000 Series Spectrophotometer with a wavelength of 500 nm. OD observations aim to see the level of turbidity of the treatment solution. Turbidity reflects the density of the fungus *T. harzianum* with a combination of siam weed. Observation of pH and OD three replications were carried out for each treatment.

Germination Parameters

Seed viability was the capability of a seed to germinate in a normal environment. The germination percentage was determined by calculating the total normal seedlings percentage in the first count (21 days after sowing) and the final count (28 days after sowing). The germination percentage formula is as follows (Damayanti *et al*., 2013):

$$\% \text{ Germination} = \frac{Normal\ Seedlings\ 21\ DAS + Normal\ seedlings\ 28\ DAS}{Number\ of\ seeds} \times 100\ \%$$

Seed vigor is the capability of a seed to germinate in a sub-optimal environment. One of the seedling vigor parameters is the simultaneity of seed growth. The vigor index (VI) defined normal seedlings percentage in the first count until the final count (17, 21, and 28 days after sowing). The formula was as follows (Damayanti *et al*., 2013):

$$VI = \frac{Normal\ germinated\ seeds}{Number\ of\ seeds} \times 100\%$$

Germination rate was observed on days 17, 21, and 28 in normally growing seeds. The germination rate was calculated by the formula (Pelealu *et al*., 2019; Panataria *et al*., 2022):

$$GR\ (\%/etmal) = \Sigma\ \frac{Normal\ germinated\ seeds}{Observation\ time}$$

Growth Parameters

Normal seedlings were characterized by bright green color, undamaged cotyledons, and growing vertically. Hypocotyl length was observed from days 28, 35, 42, 49, and 56 after sowing in each treatment. All samples in each replication were observed for hypocotyl length by measuring the bottom of the cotyledons to the base of the root using a ruler.

The number of leaves was observed on days 38, 42, 49, and 56 after sowing in each treatment. The number of leaves was calculated by counting all the number of leaves that had grown and opened in each treatment. Observation of chlorophyll content using the E-1000 series spectrophotometer. Hundred milligrams of coffee leaves was extracted with 50 mL of 80% acetone, and then filtered with filter paper. The absorbance length of the extraction solution was measured using a spectrophotometer at wavelengths of 663 nm and 646 nm (Zakariyya & Indradewa, 2018). The formula for chlorophyll content is as follows:

Chlorophyll a (mg L^{-1}) =
1.7 (*A*663) - 2.69 (*A*646)

Chlorophyll b (mg L^{-1}) =
22.9 (*A*646) - 4.68 (*A*663)

Total chlorophyll mg L^{-1}) =
8.02 (*A*663) + 20.2 (*A*646)

Data Analysis

The observations' data was processed using Microsoft Excel and SPSS version 25. Analysis of variance (ANOVA) was used to test the data. If the results showed a significant value, the Duncan Multiple Range Test was carried out.

RESULTS AND DISCUSSION

According to the ANOVA test, the combination of siam weed extract and *T. harzianum* had a significant effect on germination capacity, growth simultaneity, and growth rate (Table 1). In the control (water), germination percentage, germination rate, and growth simultaneity were the lowest compared to other treatments.

Germination evaluation aims to determine the ability of seeds to grow normally in an optimal environment (Widajati *et al*., 2013). The vigor index was determined by measuring the time at which the first normal sprouts emerged, indicated by the elevation of cotyledons by the hypocotyl. The highest vigor index was found in the siam weed extract 8 ppm + *T. harzianum* extract 10 ppm and siam weed extract 16 ppm + *T. harzianum* extract 5 ppm treatments. The combination of siam weed extract at a concentration of 8 ppm and *T. harzianum* 16 ppm, as well as a combination of 16 ppm siam weed extract and 5 ppm of *T. harzianum*, facilitates the optimal absorption of water by coffee seeds.

Water availability stimulates the germination process in the embryo. The embryo synthesizes endogenous gibberellin and subsequently releases it into the endosperm

through the scutellum. Gibberellin permeates the aleurone layers, stimulating the synthesis and secretion of enzymes (amylase, protease, and lipase) into the endosperm. During germination, the endosperm initiates the breakdown of starch and other macromolecules into smaller molecules. These molecules are subsequently transferred to the embryo, where they are utilized as a source of energy for the germination process. This molecule will accelerate the development of radicles and plumules (Suhendra *et al*., 2021).

Germination rate of seed is a method to determine the rate at which a seed can grow under optimal conditions, indicating its level of vigor or ability to develop over a specific period of time. The results indicated that the siam weed extracts 16 ppm + *T. harzianum* 0.5 g treatment exhibited the highest and most rate of seed germination. The rate of seed germination is directly correlated with germination capacity. A higher germination capacity leads to a faster seed germination (Mustiwulandari & Pudjihartati, 2022). Similar to prior parameter data, the siam weed extracts 16 ppm + *T. harzianum* 0.5 g treatment exhibited the highest germination percentage, resulting in a high growth rate (Table 1).

The siam weed extract 16 ppm + *T. harzianum* 0.5 g treatment showed a higher level of simultaneity growth. The application of 16 ppm siam weed extract in combination with 0.5 g *T. harzianum* is considered to significantly enhance absolute vigor. Lesilolo *et al*. (2013), found that a plant exhibiting high growth simultaneity is indicative of high absolute vigor.

Observation results showed that siam weed treatment combined with the T. *harzianum* fungus gave significantly different results compared to the negative control. The siam weed extract 16 ppm + *T. harzianum extract* 0.5 g treatment consistently shows the best of hypocotyl length in comparison to other treatments (Figure 1). The application of 16 ppm siam weed extract in combination with 0.5 g of *T. harzianum* is known to enhance water absorption by the roots of coffee plants. The length of the hypocotyl is determined by the level of cell division activity in the apical meristem. Meristem activity is affected by the presence of water, which works as a carrier for nutrients and minerals. Consequently, increased water absorption leads to an increase in the hypocotyl length of a plant (Fitri *et al*., 2022).

Observation results showed that siam weed treatment combined with the *T. harzianum* fungus gave significantly different results compared to the negative control. Observations on days of 38 and 42 revealed that the siam weed extract 16 ppm + *T. harzianum*

Table 1. Effect of the addition of siam weed extract (*Chromolaena odorata*) and *Trichoderma harzianum* on germination, growth simultaneity, and growth rate of Arabica coffee seeds

Combination treatment code	Germination parameters		
	Seed viability %	Simultaneity growth %	Rate of germination (%/etmal)
Control - (Co-)	17 ± 0.05 [a]	11 ± 0.03 [a]	10 ± 0.03 [a]
Control + (Co+)	65 ± 0.12 [b]	55 ± 0.12 [b]	60 ± 0.15 [b]
Siam weed extract 8 ppm + *T. harzianum* 0.5 g (C1T1)	69 ± 0.08 [b]	57 ± 0.10 [b]	62 ± 0.14 [b]
Siam weed extract 8 ppm + *T. harzianum* 1 g (C1T2)	73 ± 0.08 [b]	58 ± 0.09 [b]	66 ± 0.13 [b]
Siam weed extract 8 ppm + *T. harzianum* 1.5 g (C1T3)	69 ± 0.08 [b]	56 ± 0.10 [b]	63 ± 0.12 [b]
Siam weed extract 8 ppm + *T. harzianum* 2 g (C1T4)	65 ± 0.08 [b]	50 ± 0.02 [b]	54 ± 0.02 [b]
Siam weed extract 16 ppm + *T. harzianum* 0.5 (C2T1)	73 ± 0.08 [b]	62 ± 0.08 [b]	69 ± 0.10 [b]
Siam weed extract 16 ppm + *T. harzianum* 1 g (C2T2)	69 ± 0.09 [b]	55 ± 0.11 [b]	60 ± 0.15 [b]
Siam weed extract 16 ppm + *T. harzianum* 1.5 g (C2T3)	69 ± 0.04 [b]	58 ± 0.08 [b]	65 ± 0.11 [b]
Siam weed extract 16 ppm + *T. harzianum* 2.0 g (C2T4)	67 ± 0.02 [b]	57 ± 0.02 [b]	63 ± 0.04 [b]

Note: Numbers followed by different letters in the same column shows a significantly different effect based on the Duncan test with a confidence level of 95%.

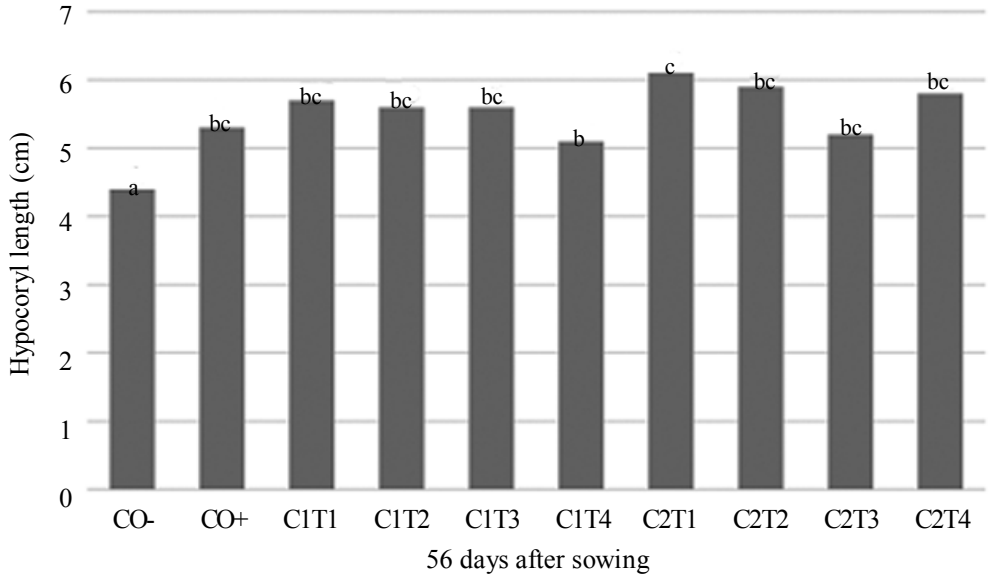

Figure 1. Effect of combining siam weed extract and *Trichoderma harzianum* on hypocotyl length

Note : Treatment code see Table 1. Bars followed by the same letter are not significantly different based on Duncan test at 95% confidence level.

2 g treatment showed the highest amount of leaves. Meanwhile, on days of 49 and 56, the siam weed extract 16 ppm + *T. harzianum* 0.5 g treatment exhibited the highest number of leaves. Negative control had the lowest number of leaves over the whole observation period (Figure 2). The combination of 16 ppm siam weed extract and 5 ppm *T. harzianum* can able to increase water absorption by the roots so that it can increase the growth of the number of leaves on Arabica coffee plants This can be seen from all treatments given weed extract siam weed and *T. harzianum* had a higher number of leaves compared to the negative control treatment (Figure 3).

The siam weed extract 16 ppm + *T. harzianum* 0.5 g is the most effective for 5 parameters. The combination of 16 ppm siam weed extract and 5 ppm *T. harzianum* has been found to efficiently provide the nutrients and hormones that are essential for the cultivation and maturation of Arabica coffee. According to Peniwiratri & Arbiwati (2021) siam weed has a very large biomass. Siam weed biomass is known to contain nutrients such as N 2.65%, P 0.53%, and K 1.9%. Siam weed at 6 months old can produce biomass of 11.2 tons ha^{-1}.

T. harzianum stimulates plant growth by enzymatically decomposing organic material to release nutrients. *Trichoderma* sp. generate enzymes, that is the cellobiohydrolase (CBH) enzyme, the endoglucanase enzyme, and the glucosidase enzyme. The cellobiohydrolase enzyme is responsible for the degradation of natural cellulose, while the endoglucanase enzyme is responsible for the degradation of soluble cellulose. The glucosidase enzyme, on the other hand, catalyzes the hydrolysis of cellobiose units into glucose molecules. These three enzymes operate together so that the decomposition of organic materials takes place more quickly (Isnaini *et al*., 2021). *Trichoderma* sp. has the ability to break down phosphate at concentrations ranging from 215.80 µg mL^{-1} to 288.18 µg mL^{-1} within 120 hours after inoculation (Bader *et al*., 2020).

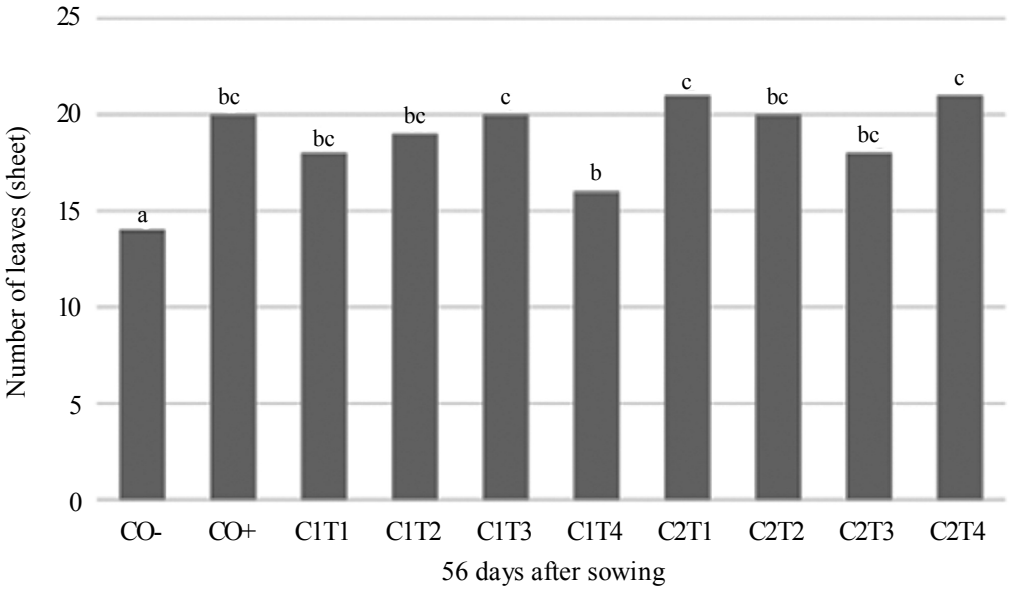

Figure 2. Effect of combining siam weed extract (*Chromolaena odorata*) and *Trichoderma harzianum* on the number of leaves.

Note : Treatment code see Table 1. Bars followed by the same letter are not significantly different based on Duncan test at 95% confidence level.

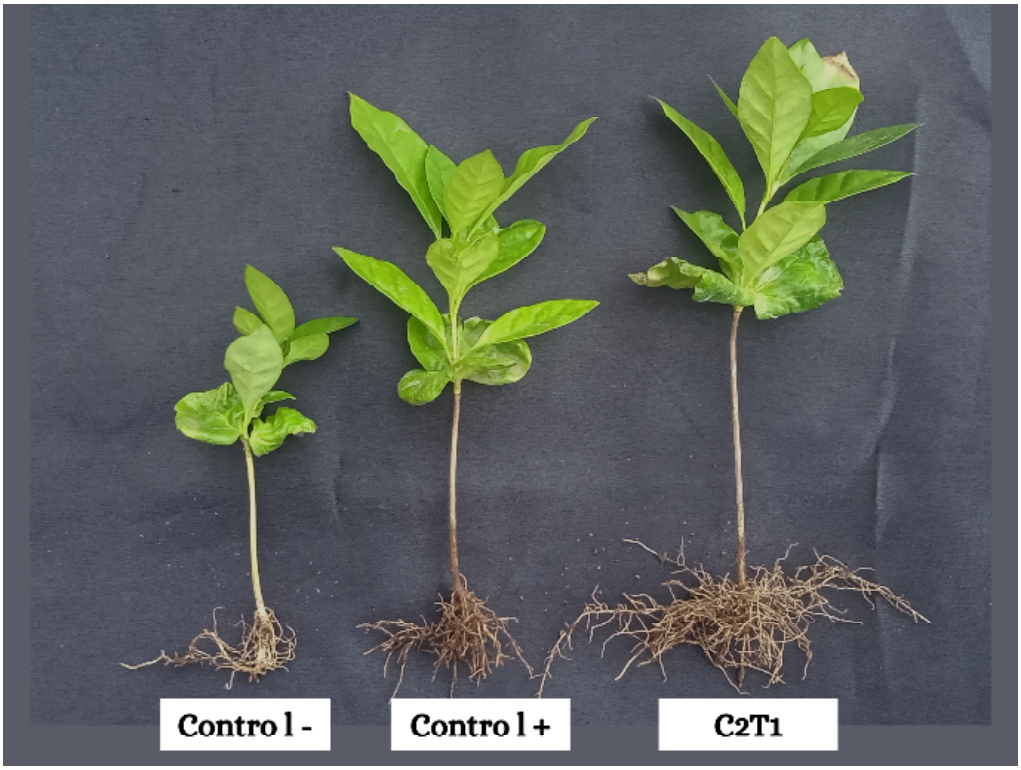

Figure 3. Morphology of Arabica coffee seedlings 262 days after sowing

Notes : Treatment code see Table 1.

T. harzianum has the ability of synthesizing the hormone auxin in the form of IAA (Indole Acetic Acid), at a concentration ranging from 13.38 µg mL^{-1} to 21.14 µg mL^{-1} in five days in vitro (Bader *et al*., 2020). Fitria *et al*. (2021) showed that *T. harzianum* produced 68 µg mL^{-1} of the IAA hormone after 3 days of incubation at a temperature of 30 ^{0}C. *T. harzianum* synthesizes the hormone indole-3-acetic acid (IAA) at the apical and epidermal regions of plant roots. The IAA hormone stimulates the development of secondary roots, the formation of fibrous roots, and increases the response of roots to the absorption of nutrients and water in the soil (Hopkins & Huner, 2008).

T. harzianum is able to produce enzymes (chitinases, proteases and glucanases) and antibiotics (alkyl pyrones, isonitriles and polyketides). This compound functions to inhibit the growth of pathogenic microorganisms which can cause disease in plant roots (Berlian *et al.*, 2013). It was proven that the siam weed extract 16 ppm + *T. harzianum extract* 0.5 treatment had healthier and denser roots compared to the control (Figure 2).

The results indicate that the pH and particle density based on Optical Density values levels have no significant effect on germination and growth in Arabica coffee plants (Table 2). *T. harzianum* may grow optimally in pH ranges of 3–7 (Cikita *et al*., 2016). The pH value of *T. harzianum* in combination with siam weed extract increased as the concentration of extract increased. According to Mulyadi *et al*. (2022), treatment compost with *Trichoderma* sp. can increase pH to the range of 5.8–6.46. The average pH is close to the optimal range for onion plant growth.

Optical Density (OD) is a parameter to see the level of turbidity of a solution. The level of turbidity reflects the density of a particle, if the OD value is high, the higher the population or particles contained in the environment. The research results showed that the concentration of the fungus *T. harzianum* combined with 8 ppm of siam weed increased along with the addition of the fungal concentration. Meanwhile, the OD value in the combination treatment of siam weed and the fungus *T. harzianum* 16 ppm did not increase. This is possible because too high a concentration of siam weed can disrupt the growth of the fungus *T. harzianum* (Table 2).

The results of the ANOVA test showed that administration of siam weed extract and *T. harzianum* mushroom had a significant effect on chlorophyll a levels compared to the negative control treatment, but had no significant effect on chlorophyll b and total chlorophyll levels (Table 3). This result is possible because the solvent used when testing chlorophyll levels is less than optimal for measuring chlorophyll b levels. In this study, the solvent used was acetone, according to Novitasari *et al*. (2018), acetone solvent dissolves more chlorophyll a than chlorophyll b. This is because chlorophyll a is less polar while chlorophyll b is polar

Chlorophyll is a photosynthetic pigment that absorbs light and facilitates energy transmission (Ziadaturrif'ah *et al.*, 2019). The results showed that the treatment with siam weed extract 16 ppm + *T. harzianum* extract 2 g had the highest chlorophyll content (Table 3). The combination of 16 ppm siam weed extract and 2 g *T. harzianum* is able to provide optimal nutrients for chlorophyll synthesis such as magnesium. According to Suntoro *et al*. (2001) Siam weed leaves contain quite high amounts of the nutrient magnesium, the magnesium content is increasingly optimal with the presence of the fungus *T. harzianum* which can break down the nutrients needed by plants (Salma & Gunarto, 1996).

These results were proven by the high percentage of germination and growth compared to the control coffee beans. According to Ardiasyah *et al.* (2022), plants with high chlorophyll content indicate that these plants have

Table 2. pH and particle density (based on optical density measurement) analysis of siam weed (*Chromolaena odorata*) extract in the combination with *Trichoderma harzianum*

Treatment	Parameter	
	pH	Particle density (OD values based)
Control -	5.23	0.03
Control +	6.07	2.77
Siam weed extract 8 ppm + *T. harzianum* 0.5 g	4.70	0.20
Siam weed extract 8 ppm + *T. harzianum* 1 g	5.30	0.43
Siam weed extract 8 ppm + *T. harzianum* 1.5 g	5.37	0.83
Siam weed extract 8 ppm + *T. harzianum* 2 g	5.40	1.20
Siam weed extract 16 ppm + *T. harzianum* 0.5	4.87	0.17
Siam weed extract 16 ppm + *T. harzianum* 1 g	5.27	1.23
Siam weed extract 16 ppm + *T. harzianum* 1.5 g	5.30	0.97
Siam weed extract 16 ppm + *T. harzianum* 2.0 g	5.37	1.07

Note: Particle density is based on optical density.

Table 3. Effect of the addition of siam weed (*Chromolaena odorata*) extracts and *Trichoderma harzianum* on the chlorophyll content of Arabica coffee leaves

Treatment	Chlorophyll a	Chlorophyll b	Total chlorophyll
	mg L^{-1}		
Control -	1.64 ^{a}	3.62 ^{c}	5.25 ^{abc}
Control +	3.75 ^{c}	3.22 ^{bc}	5.97 ^{cd}
Siam weed extract 8 ppm + *T. harzianum* 0.5 g	3.50 ^{bc}	2.95 ^{abc}	6.45 ^{bcd}
Siam weed extract 8 ppm + *T. harzianum* 1 g	3.44 ^{bc}	2.75 ^{abc}	6.19 ^{abcd}
Siam weed extract 8 ppm + *T. harzianum* 1.5 g	3.64 ^{bc}	2.46 ^{ab}	6.09 ^{abcd}
Siam weed extract 8 ppm + *T. harzianum* 2 g	2.97 ^{bc}	1.97 ^{a}	4.94 ^{abc}
Siam weed extract 16 ppm + *T. harzianum* 0.5	3.13 ^{bc}	2.35 ^{ab}	5.48 ^{abc}
Siam weed extract 16 ppm + *T. harzianum* 1 g	3.50 ^{bc}	2.95 ^{abc}	5.45 ^{bcd}
Siam weed extract 16 ppm + *T. harzianum* 1.5 g	2.66 ^{b}	1.87 ^{a}	4.52 ^{a}
Siam weed extract 16 ppm + *T. harzianum* 2.0 g	4.10 ^{c}	3.38 ^{bc}	7.48 ^{d}

Note: Numbers followed by different letters in the same column shows a significantly different effect based on the Duncan test with a confidence level of 95%.

high growth rates and productivity. The chlorophyll content in plants is influenced by various factors such as light, carbohydrate sugars, water, temperature, genetics, and nutrient availability (Song & Banyo, 2011).

CONCL9USIONS

The combination of 16 ppm siam weed and 0.5 g *Trichoderma harzianum* fungus is the best treatment to speed up the coffee seed germination process. This is proven by the high results of observations on the parameters of seed viability, seed growth simultaneity, seed growth speed, hypocotyl length, and number of leaves. The roots of coffee seedlings with this combination treatment also support the seed germination process. Meanwhile, the combination treatment of siam weed and *Trichoderma harzianum* fungus had no significant effect on the chlorophyll content of coffee leaves.

ACKNOWLEDGEMENT

The authors are highly thankful to Ari Wahono, Hikmatullah Adi Cahyo, Rais Widyanto from Indonesian Coffee and Cocoa Research Institute for collecting the data and supporting the research works.

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