Effect of compost enrichment with *Trichoderma* sp on the growth of Arabica coffee seedlings

A Ala, Y Musa, and L Kadola

Department of Agronomy, Universitas Hasanuddin, Jl. Perintis Kemerdekaan KM.10 Makassar, Indonesia

Email: yunusmondi@gmail.com

**Abstract.** An experiment was conducted to determine and study the effect of adding *Trichoderma* sp. on compost for the growth of Arabica coffee seedlings (*Coffea arabica* L.). The research design was a complete randomized design (CRD) of a two-factor factorial pattern. Compost was the first factor consisted of 4 levels: 0 g per polybag, 100 g per polybag, 200 g per polybag, 300 g per polybag, and *Trichoderma* sp addition as the second factor consisting of 4 levels, namely: 0 g per polybag, 1 g per polybag, 2 g per polybag, 3 g per polybag. The results showed that the compost dosage of 300 g / polybag gave the best results on average leaf area parameters (22.22 cm), stem diameter (3.27 mm), and the highest percentage of successful shoot grafting which was 86.11%. Addition of 2 g *Trichoderma* sp. per polybag gave the best results on leaf area at the age of 6 week after planting of 6.38 cm.

1. **Introduction**

South Sulawesi is a Province in Eastern Indonesia that has the potential for coffee development. During 2017, South Sulawesi produced an average of 30,992 tons of coffee within an area of 46,816 hectares [1]. One type of coffee that is widely developed is the Arabica coffee with fairly extensive planting area and a very supportive agro-climatological situation. Based on data from the South Sulawesi Plantation Office [2], the volume of Arabica coffee exports from South Sulawesi in the 2017 period was 4.11 million tons with an export value of 14.45 million US dollars. Of the total volume of Arabica coffee exports, most were sent to the US namely 1.9 million tons, then Japan 628,037 tons, and Belgium 379,200 tons. While coffee exports to Italy were only 36,000 tons with an export value of 113,400 US dollars. This province contributed to around 12.29% of total Arabica coffee production of Indonesia [3].

Efforts for increasing productivity starts in the nursery by propagating and developing types of coffee that have superior genetic potential. Development requires quality seedlings in sufficient quantity. These criteria can be obtained through vegetative propagation. One of them is the shoot grafting technique. Shoot grafting technology is the merging of two individual coffee plants with the same species [4].

Planting media for nurseries of estate crops generally have organic matter in addition to the soil [5]. Growing media for coffee seedlings in nurseries is a mixture of topsoil, fine sand and manure (1: 1: 1) depending on the soil conditions [6].

Abdurohim [7] stated that compost provides an increase in potassium levels in the soil higher than the potassium supplied by NPK fertilizer. Application of compost at doses of 200, 300, and 400 g per
polybag for cocoa seedlings were better than seedlings without compost in the growing media. At the doses of 300 and 400 g per polybags, the seedling showed better growth results in seedlings’ height compared to those without compost application [8].

Application of Trichoderma sp. in composting can accelerate the process and improve the quality of compost produced. This fungus produces the enzymes cellobiohidrolase, endoglyconase, and glojosidase that work synergistically so that the decomposition process is more quickly [9]. Besides being a decomposing organism Trichoderma sp. can also function as a biological agent and stimulator of plant growth. Trichoderma sp. also acts as a biodecomposer within planting area, help decompose organic waste into quality compost. Besides the ability as a biological controller Trichoderma sp. give positive effect to plant roots, plant growth and crop yields [10].

Advantages of Trichoderma sp. such as easy to apply, does not produce toxic substance, is environmentally friendly, does not interfere with other organisms especially those in the soil, and does not increase residues in the soil or plants [10]. Several studies had shown that Trichoderma sp. can control diseases caused by fungi [11-13].

2. Methodology

The research was arranged with a complete randomized design (CRD) factorial pattern, consisting of two treatment factors. The first factor was compost (k) consisted of four levels, namely: k0: without composting; k1: 100 g/polybag k2: 200 g/polybag k3: 300 g/polybag. The second factor was the addition of Trichoderma sp. (t) which consisted of four levels, namely: t0: no Trichoderma sp. addition; t1: 1 g/polybag t2: 2 g/polybag t3: 3 g/polybag.

2.1. Planting medium preparation

Materials for composting were coffee husks, buffalo manure, gamal leaves (1:1:1). Composting was carried out for approximately 1 month. Compost was ready for use is when the color turned black and the odor was not strong. Soil for planting medium derived from around plantation. The soil was utilized after a treatment to remove wastes and weeds. The Trichoderma sp was added to containers of the plating medium according to the treatment. This treatment was applied 2 weeks before planting. Polybags containing soil and compost are arranged according to the treatment with a distance of 30 cm.

2.2. Seedlings transplanting

The seedlings of Arabica coffeer in this experiment was Lini S variety. As many as 144 seedlings which had been selected for criteria of viable and uniformed growth, and free from pests and diseases. The seedlings were planted by plugging them into the planting medium about 15 cm deep to the extent of the root neck. This was done carefully so that the roots were not damaged.

2.3. Shoot grafting

The shoot grafting was started by preparing the scions and the rootstocks. The rootstock which was about 4 months old was the lower part of stem at a length of 15 cm. The rootstock was then sliced on the top with a sharp knife or cutter as deep as 2 cm to form the letter v. The scion as the upper entres was taken form a healthy parent coffee plant. It was sliced along 2 cm on both sides. The final step was inserting the scion into the v gap in the rootstock. The rafting connection was then wrapped with plastic. The seedlings were then covered by transparent plastic to maintain moisture.

3. Results and discussion

Observation on all variables presented in this papers are data recorded 12 weeks after planting (WAP). The observed variables are plant height (cm), number of leaves, leaf area (cm), stem diameter (mm), graft success rate (%), root volumes (ml) and root infection rate (%). The following figures and tables present the results of observation.
Figure 1. Average plant height with application of compost and *Trichoderma* sp. at 12 weeks after planting (WAP)

The results revealed that the treatment of compost, *Trichoderma* sp and the interactions did not significantly affect plant height. Figure 1 shows that the treatment 300 g of compost (k3) with 2 g of *Trichoderma* sp. (t2) produced the highest plant height with a value of 23.63 cm, while the treatment of 100 g compost (k2) with 1 g of *Trichoderma* sp. (t1) gave the lowest plant height with a value of 20.54 cm.

Figure 2. Average number of leaves with application of compost and *Trichoderma* sp. at 12 weeks after planting (WAP)

The results revealed that the treatment of compost doses, *Trichoderma* sp. and the interaction had no significant effect on the number of leaves. Figure 2 shows that the treatment of 300 g compost (k3) with 2 g of *Trichoderma* sp. (t2) produced the highest number of leaves with an average value of 10.89 strands, while the no compost treatment (k0) with no *Trichoderma* sp. (t0) gave the lowest number of leaves with an average value of 9.36 strands.

### Table 1. Average leaf area (cm) of Arabica coffee seedlings in various doses of compost and *Trichoderma* sp. at 12 weeks after planting (WAP)

| *Trichoderma* sp | Compost | Average | LSD 0.05 |
|------------------|---------|---------|----------|
|                  | k0      | k1      | k2       | k3       |         |
| t0               | 20.64   | 19.10   | 15.99    | 23.96    | 19.92   |
| t1               | 23.16   | 20.53   | 19.96    | 21.20    | 21.21   |
| t2               | 22.23   | 19.25   | 19.04    | 20.52    | 20.26   |
| t3               | 21.09   | 21.53   | 17.24    | 23.20    | 20.76   |
| **Average**      | **21.78** | **20.10** | **18.06** | **22.22** |         |

**LSD 0.05** 2.08

Notes: The numbers followed by the same letters in the column (abc) indicates no significant difference in the LSD test level of 5%.
The results revealed that the treatment of compost significantly affected leaf area while the treatment of *Trichoderma* sp. and the interaction had no significant effect on leaf area. Table 1 shows that the treatment of compost at a dose of 300 g per polybag (k3) produced the leaf area with the highest value of 22.22 cm which was not significantly different from the no compost treatment (k0), but significantly different from the treatment of 100 g compost (k1) and 200 g of compost (k2) with the lowest average leaf area of 18.06 cm.

Leaf width increase was significant because it is influenced by nutrients in organic fertilizer. Growth in leaf area is influenced by levels of N sufficient for coffee plants. In addition to N, it was also caused by sufficient levels of Mg. Magnesium (Mg) is a nutrient that plays a role in the formation of chlorophyll, activating the phosphorylation process that supports the work of phosphorus (P) in the transfer of ATP energy (adenine triphosphate) [14].

Table 2. Average stem diameter (mm) of Arabica coffee seedlings in various doses of compost and *Trichoderma* sp. at 12 weeks after planting (WAP)

| Trichoderma sp | Compost | Average | LSD 0.05 |
|----------------|---------|---------|----------|
|                | k0      | k1      | k2       | k3       |         |
| t0             | 2.86    | 3.00    | 3.09     | 3.38     | 3.08    |
| t1             | 2.88    | 2.91    | 3.12     | 3.51     | 3.10    |
| t2             | 2.94    | 3.04    | 2.91     | 3.01     | 2.98    |
| t3             | 3.02    | 2.99    | 2.91     | 3.21     | 3.03    |
| Average        | 2.92    | b       | 2.99     | b        | 3.01    | b       | 3.27   | a       |
| LSD 0.05       | 0.16    |

Notes: The numbers followed by the same letters in the column (abc) indicates no significant difference in the LSD test level of 5%.

The results revealed that the treatment of compost doses had a significant effect while the treatment of several doses of *Trichoderma* sp. and the interaction had no significant effect on stem diameter. Table 2 shows that the treatment of compost at a dose of 300 g (k3) produced an average highest stem diameter of 3.27 mm which was significantly different from the treatment of 200 g (k2), 100 (k1), and 0 g (k0) compost with the lowest average stem diameter of 2.92 mm.

Results of a research by Falahuddin, Raharjeng, & Harmeni [15], was in accordance with this finding. The study revealed the application of coffee husk compost to coffee plants several vegetative and generative variables. It confirms that the nutrient content of compost, especially the high N elements, can help the vegetative process of vegetation. According to Soepardi [16], nitrogen is able to stimulate growth above ground, and one of them is stem diameter growth.

Table 3. Average graft success rate (%) of Arabica coffee seedlings in various doses of compost and *Trichoderma* sp. at 12 weeks after planting (WAP)

| Trichoderma sp | Compost | Average | LSD 0.05 |
|----------------|---------|---------|----------|
|                | k0      | k1      | k2       | k3       |         |
| t0             | 33.33   | 88.89   | 33.33    | 77.78    | 58.33   |
| t1             | 77.78   | 33.33   | 100.00   | 77.78    | 72.22   |
| t2             | 44.44   | 77.78   | 44.44    | 100.00   | 66.67   |
| t3             | 44.45   | 66.67   | 44.44    | 88.89    | 61.11   |
| Average        | 50.00   | b       | 66.67    | b        | 55.56   | b       | 86.11  | a |
| LSD 0.05       | 24.30   |

Notes: The numbers followed by the same letters in the column (abc) indicates no significant difference in the LSD test level of 5%.
The results revealed that the treatment of compost doses had a significant effect while the treatment of *Trichoderma* sp. and the interaction had no significant effect on graft success rate. Table 3 shows that the treatment of compost at a dose of 300 g per polybag (k3) produced highest percentage of graft success rate of 86.11%, which was not significantly different from the treatment of 100 g compost (k1) but significantly different from the treatment of 200 g (k2) and 0 g (k0) compost with the lowest average success rate percentage at 50.00%.

According to Harjadi [17] there are several factors that could affect the success of graftings, namely the origin of the cuttings (the position of cuttings in the parent plant), the length of the cuttings, and the environment (rooting media, temperature, humidity, sun radiation). Also importantly, the availability of sufficient food material for the growth of cuttings.

**Table 4.** Observation of Arabica coffee root volume (ml) with various doses of compost and *Trichoderma* sp.

| Treatments | Root Volume (ml) |
|------------|------------------|
| k0t0       | 2.0              |
| k1t0       | 3.0              |
| k2t0       | 3.0              |
| k3t0       | 2.0              |
| k0t1       | 2.0              |
| k1t1       | 2.0              |
| k2t1       | 3.0              |
| k3t1       | 2.0              |
| k0t2       | 2.0              |
| k1t2       | 3.0              |
| k2t2       | 3.0              |
| k3t2       | 4.0              |
| k0t3       | 3.0              |
| k1t3       | 2.0              |
| k2t3       | 2.0              |
| k3t3       | 3.0              |
| Total      | 41.0             |

Table 4 showed that one treatment combination i.e. between the 300 g of compost and 2 g *Trichoderma* sp. (k3t2) produced the largest root volume with a value of 4 ml. The increasing compost dose can increase the availability of nutrients for plants so that the volume of plant roots becomes greater to absorb nutrients. According to Yuwono [18] one of the functions of organic fertilizer is to improve soil structure. Good soil has a good porous system to enable air and water flow which will assist plant roots to develop better. The more compost is given, the better the soil and the better the growth of the roots of the coffee seedlings.

**Table 5.** Observation of Arabica coffee root infection rate (%) with various doses of compost and *Trichoderma* sp.

| Treatments | Number of infected samples | Rate of infection by *Trichoderma* sp. |
|------------|-----------------------------|----------------------------------------|
| k0t0       | 0                           | 0                                      |
| k1t0       | 0                           | 0                                      |
| k2t0       | 0                           | 0                                      |
Table 5 shows that one treatment combination i.e. between the 300 g compost dose and the 2 g of *Trichoderma* sp (k3t2) had the highest level of infection by *Trichoderma* sp. which was 12.5% and the lowest infection rate was the k0t0 treatment with 0% infection.

The results of variance also showed that the interaction between compost with *Trichoderma* sp. were not significant on all parameters observed. This is likely to occur because of compost and *Trichoderma* sp. had not have sufficient time to synergize each other, hence one could be more dominant than others. Sutedjo [19], stated that if one factor is more influential than the other, it means that the other factors’ influence could have been out dominated. Each factor might have very different nature of influence and work characteristics, it could lead to a different relationship in influencing plant growth.

### 4. Conclusion

Almost all parameters were not significantly affected the treatment of *Trichoderma* sp addition. This is presumably due to many factors that influence more on the growth and yield of coffee plants, such as genetic and environmental conditions. However, application of 300 g compost per polybag had significant effects on leaf area, stem diameter, and the percentage of graft success rate, whereas application of 2 g of *Trichoderma* sp. per polybag gave the best effect on the growth of leaf area.

### References

[1] Kementerian Pertanian 2017 Statistik Perkebunan Indonesia Komoditas Kopi 2015-2017  
[2] Dinas Perkebunan Sulawesi Selatan 2018 Laporan Tahunan Dinas Perkebunan Provinsi Sulawesi Selatan.  
[3] Musa Y, Iswoyo H, Sarif L and Herdjiono M V I 2019 Analysis on correlation of cultivation practices on production of Arabica coffee *IOP Conference Series: Earth and Environmental Science* vol 343  
[4] Prastowo N H 2006 *Tehnik pembibitan dan perbanyakan vegetatif tanaman buah* (World Agroforestry Centre)  
[5] S A Paembonan B B and S H L 2019 Vegetative propagation with branch cuttings as a solution for the mass development of giant atter species (*Gigantochloa atter* (Hassk) Kurz) in industrial plantations *Vegetative propagation with branch cuttings as a solution for the mass development of IOP Conf. Ser. Earth Environ. Sci. 343 012049 343* 1–9  
[6] Rahardjo P 2012 *Kopi: Panduan Budi Daya dan Pengolahan Kopi Arabika dan Robusta*, Cetakan 1 *Penebar Swadaya, Jakarta. Hal* 7–10  
[7] Abdurohim O 2010 Pengaruh Kompos Terhadap Ketersediaan Hara Dan Produksi Tanaman Caisin Pada Tanah Latosol Dari Gunung Sindur, sebuah skripsi *Dalam IPB Repos.*
[8] Indrawan I, Kusumastuti A and Utoyo B 2015 Pengaruh pemberian kompos kiambang dan pupuk majemuk pada pertumbuhan bibit kakao (Theobroma cacao L.) J. Agro Ind. Perkeb. 3 47–58
[9] Salma S and Gunarto L 1999 Enzim selulase dari Trichoderma spp Bul. AgriBio 2
[10] Wulandari D 2012 Pengaruh dekomposer Trichoderma harzianum terhadap pertumbuhan dan hasil sawi hijau pada tanah gambut Artik. Ilm. Jur. Budid. Pertan. Univ. Tanjungpura Pontianak
[11] Ismail N and Tenrirawe A 2010 Potensi Agens Hayati Trichoderma spp. sebagai Agens Pengendali Hayati Seminar Regional Inovasi Teknologi Pertanian. Balai Pengkajian Teknologi Pertanian, Sulawesi Utara
[12] Alfizar A, Marlina M and Susanti F 2013 Kemampuan antagonis Trichoderma sp. terhadap beberapa jamur patogen in vitro J. Floratek 8 45–51
[13] Anand S and Reddy J 2009 Biocontrol potential of Trichoderma sp. against plant pathogens Int. J. Agric. Sci. 1 30
[14] Sutiyoso Y 2003 Aeroponik Sayuran (Budidaya dengan Sistem Pengabutan) Penebar Swadaya, Jakarta
[15] Falahuddin I, Raharjeng A R P and Harmeni L 2016 Pengaruh Pupuk Organik Limbah Kulit Kopi (Coffea Arabica L.) Terhadap Pertumbuhan Bibit Kopi J. Bioilmi 2
[16] Soepardi G 1983 Sifat dan Ciri Tanah. Departemen Ilmu Tanah Fak. Pertanian. Inst. Pertan. Bogor. Bogor
[17] Harjadi M M 2015 Pengantar Agronomi. Gramedia Pustaka Utama. Jakarta J. AIP 3 94–107
[18] Yuwono D 2005 Kompos (Compost) (Penebar Swadaya. Jakarta)
[19] Sutejo M M and Kartasapoetra A G 1990 Pupuk dan cara pemupukan (Rineka Cipta)