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Tea Grounds and Coffee Grounds Support Sustainable Growth of Mustard Plants

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Abstract: The concept of organic farming is an effort to maintain optimal levels of environmentally friendly production. Therefore, this research aims to determine the effect of adding tea dregs and coffee dregs to compost media alone or mixed as additional nutrients on the growth of mustard greens (Brassica juncea L.). This research used a Completely Randomized Design (CRD) consisting of 4 treatments with 3 replications, namely compost without tea dregs and coffee dregs as control (P0). The research data were analyzed using Analysis of Variance (ANOVA) and Least Significant Difference Test (LSD) at a significance level of 5%. The results of the research obtained were that giving tea dregs and coffee dregs to the mustard plant planting medium obtained positive results. Single application of tea dregs had a significant effect on plant height (9.80 cm) and number of leaves (7.5). The treatment with tea dregs also had a significantly different effect from the control and other treatments. Meanwhile, coffee grounds alone contributed to a plant height of 7.1 cm and a number of leaves of 3.75, where the results obtained were not significantly different from the control and other treatments. However, overall, both single and mixed treatments had no significant effect on plant root length. The results of the ANOVA analysis for growth with the mustard plant height parameter obtained a value of Fcount of 4.496 > Ftable, namely 3.49, the parameter number of leaf blades Fcount 8.757 > Ftable, namely 3.49, and the root length parameter Fcount 0.367 < Ftable 3.49.

Keywords: Coffee dregs; Compost tea dregs; Mustard Plants; Organic farming

Introduction

Indonesia's mustard greens production in 2022 was 7.606.082 tons with an average consumption rate of 0.029 tons. Alanazi (2023) predicts that mustard greens production will increase by 0.989% from 2020-2029, as well as consumption rates with an increasing trend of 1.144% in the same year. This prediction shows that there is a trend of increasing consumption rates greater than the trend of increasing production so that there will be a gap in availability. The level of interest in mustard greens is directly proportional to the benefits obtained by consumers. The nutrients contained in every 100 g of wet mustard greens are 2.3 g protein, 0.2 g fat, 4.0 g carbohydrates, 38.0 mg Ca, 38.0 g P, 2.9 g Fe, 1.94 mg vitamin, 0.09 mg vitamin B, 102 mg vitamin C and 22.0 calories of energy (Erenstein et al., 2022). On the other hand, mustard greens production continues to fluctuate, one of which is caused by the planting medium and the nutrients in it. Therefore, the development of planting media formulations is a solution step in supporting the availability of mustard greens. The prediction of the existence of household organic waste in Indonesia is estimated to reach 150.000

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tons/day in 2025, which is dominated by household waste ranging from 60 to 75 percent (Farahdiba et al., 2023).

Tea dregs and coffee grounds are among the types of waste that can be used as organic planting media to support plant growth. This alternative adopts an ecological approach so that the orientation of increasing production remains side by side with the preservation of nature. The same thing was done by Chu et al. (2023), who intervened in the use of chemicals in shallot cultivation to prevent land degradation. Tea dregs waste that is found usually contains 10% Magnesium (Mg), and 13% Calcium can help plant growth (Pane et al., 2023). Providing tea dregs can provide plant growth regulators and phytohormones and stimulate microorganisms that have direct or indirect effects on the plant rhizosphere, improve the physical and chemical properties of the soil and suppress several plant disease pathogens (Bouchtaoui et al., 2024). The content of organic compounds such as polyphenols, flavonoids, tannins, and caffeine can have a positive impact on soil properties and plant growth (Stiller et al., 2021).

Alternative utilization of tea dregs waste as a planting medium has the potential to be an important source of nutrients available to plants such as nitrogen (N), phosphorus (P), potassium (K), sulfur (S), and magnesium (Mg), thereby reducing the amount of synthetic fertilizer input needed (Debnath et al., 2021). Research by Ho et al. (2022), shows that tea dregs compost can improve the physical and chemical properties of the soil, including pH, organic matter content, and nutrient availability. Other results show that tea dregs compost can increase the growth of lettuce and tomato plants (Eudoxie et al., 2019). In addition to growth, Kursa et al. (2022) explains that tea dregs extract can inhibit the growth of several plant pathogenic fungi, including: Bipolaris maydis, Colletotrichum musae and Fusarium oxysporum. Coffee grounds also provide growth nutrients for plants when used as compost.

Caffeine compounds, chlorogenic acid, diterpenes, cafestol, kahweol, trigonelline, vitamin B3, magnesium, and potassium, which provide antioxidant, antimicrobial, anti-inflammatory, antifibrotic, and anticancer properties (Samoggia et al., 2019). On the other hand, coffee production according to the International Coffee Organization (ICO) estimates that in 2020/21 it will increase to 167.26 million bags or an increase of 8.6% compared to the previous year. Therefore, the use of coffee grounds needs special attention such as the application of compost which has a positive impact on soil fertility because it contains bioactive compounds such as phenols, carotenoids, and vitamins (Gonçalves et al., 2023; Negrean et al., 2024). The benefits of coffee grounds have been proven by (Cervera-Mata et al., 2018), who reported that adding coffee grounds to the soil can increase the dry weight and yield of lettuce plants.

As well as increasing the content of antioxidant compounds and providing essential macro and micro elements in the leaves. The role of organic matter is a soil conditioner that provides a natural source of energy for microorganisms to produce nutrients (Talapko et al., 2022). Alternative use of tea grounds and coffee grounds can instruct the use of excessive chemicals. Environmental damage due to chemical fertilization methods will further impact the lack of soil capacity to support increased production. The concept of organic farming is defined as the cultivation of unpolluted plants using biofertilizers and biopesticides. The use of food waste such as tea grounds and coffee grounds to obtain biostimulants and soil amendments is an integrated practice (Xu & Geelen, 2018). This practice will help reduce the use of chemical fertilizers in agriculture and consequently water and soil pollution, one of the causes of reduced soil fertility.

The nutritional content of tea dregs and coffee dregs can increase the availability of nutrients, plant health, and suppress disease development (Suswati et al., 2022; Azwana & Sihotang, 2023). Therefore, this study focuses on examining; the ecophysiological aspects of mustard plant growth in tea dregs and coffee dregs compost planting media. Observation of the response to the influence of the method provided aims to assess the extent of the potential for utilizing tea dregs and coffee dregs waste.

Method

The research was conducted at the Experimental Field of the Faculty of Agriculture, Puangrimaggalatung University, Sengkang in August-September 2024. The materials used included tea dregs, coffee dregs, mustard greens seeds that had been sown and compost as a planting medium (made from cow dung, rice husk charcoal, molasses and EM4 fermented for 7 days). While the tools used were 30x30 polybags, rulers, scales and writing instruments. This study used a Randomized Block Design (RAK), 4 treatments with 3 replications and consisted of 2 plants for each treatment. The research experiment was carried out using a direct application approach or direct administration of tea dregs and coffee dregs to polybags with concentrations according to the treatment. Preparation for observation began with the transfer of mustard greens seeds that had been sown to polybags with a planting medium in the form of compost that had been prepared beforehand. The provision of tea dregs and coffee dregs was done by sprinkling around the plant stems on the surface of the polybag. Next, the plants were watered in the morning at 06.00 and in the afternoon at 16.00 for each day during the observation.

Table 1. Experimental Treatment Design

	Repeat (U)			
Treatment (P)	1	2	3	4
P0	P_0U_1	P_0U_2	P_0U_3	P_0U_4
P1	P_1U_1	P_1U_2	P_1U_3	P_1U_4
P2	P_2U_1	P_2U_2	P_2U_3	P_2U_4
P3	P_3U_1	P_3U_2	P_3U_3	P_3U_4

Description:
P0: compost without tea grounds and coffee grounds
P1: compost with 2 grams of tea grounds
P2: compost with 2 grams of coffee grounds
P3: compost with 1 gram of tea grounds and 1 gram of coffee grounds

Furthermore, randomization of treatments was carried out as a modeling of planting in the field. Randomization of experimental placement was carried out simply using a lottery technique (Leo at all, 2023). So that the placement of the experiment was obtained on the experimental placement plan of a completely randomized design arranged as follows:

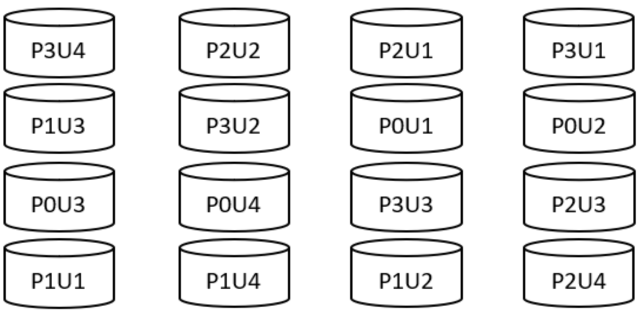

Figure 1. Results of treatment randomization

The study was conducted for one month with an observation period of 4 times each week. Observation variables were measured in the first week after planting (day 7), the second week (day 14), the third week (day 21), and the fourth week (day 28). Data collection was carried out by measuring and calculating. Measurements were made to observe the observation variables of the study, namely the number of leaves, root length and plant height. While the calculation of observation results was carried out to see the results of the study based on observation variables. The observation data were tabulated using Microsoft Excel 2013. Furthermore, the data were analyzed using Analysis of Variance (ANOVA) at a significance level of 5% to determine whether there were differences or influences in each treatment to obtain significant data on the growth of mustard plants. If there was a difference from the analysis, further testing was carried out with BNT (Small Real Difference) at a significance level of 5%.

Result and Discussion

The effect of giving tea dregs and coffee dregs individually or in a mixture showed different results on the growth variables of mustard greens (Brassica juncea L.). The results of observations showed that the treatment of giving tea dregs (P1) to the planting medium gave the best results compared to other treatments (P0, P2 and P3) in increasing plant height and number of leaves. While in the overall root length variable, the treatment was not better than the control. Differences in concentration and compound materials are the basis for the variation in the values produced.

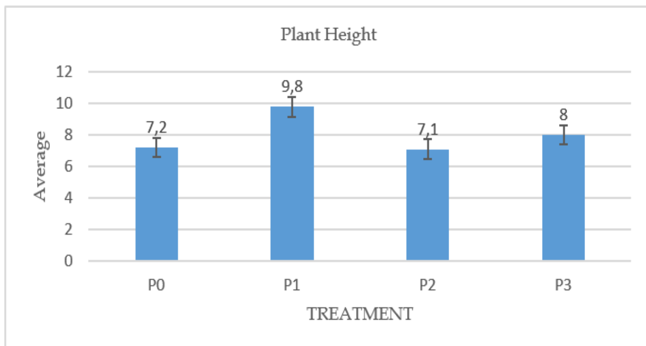

Figure 2. Average results of plant height

Figure 2 shows that treatment P1 obtained the highest growth value with an average of 9.8 cm, followed by P3 with a value of 8 cm. then P0 of 7.2 and treatment P2 showed the lowest plant height growth with an average of 7.1 cm. Meanwhile, the results of data analysis for the height of mustard greens (Brassica juncea L.) in table 1 show that the Fcount value of 4.496 is greater than Ftable of 3.49 for a significance level of 5%. This means that H0 is rejected, meaning that there is a real (significant) effect on the provision of tea dregs and coffee dregs with compost media.

Table 2. Results of Data Analysis of ANOVA and BNT Plant Height Tests

Treatment	Average Treatment	P0	P1	P2	P3	BNT	F count	Ftable (0.05)
P0	7.20	a	b	a	a			
P1	9.80	b	a	b	a			
P2	7.10	a	b	a	a	1.83	4.496*	3. 49-5.95
P3	8	a	a	a	a			

Description: * = significantly affected; b= significantly different; a= not significantly different

The real effect of each treatment on the observation variable of plant height is then the basis for testing the Least Significant Difference (LSD) to see the difference in the effect of each treatment. The results obtained were a LSD value of 1.83 at a significance level of 5%. Other results obtained were that P1 was significantly different from other treatments (P1, P3, and P0). While other treatments were not significantly different for each except P1. This strengthens the results of the average plant height that P1 with the provision of tea dregs in the compost media has a good impact on plant height. According to Zhang et al. (2024) and Huang et al. (2022), tea dregs contain phosphorus and potassium whose presence in tea dregs contributes to increased growth of plant roots and stems. Tea dregs that decompose in the planting medium have micronutrients such as manganese, iron and zinc which are beneficial for plant growth and development (Guardiola-Márquez et al., 2023). The use of tea dregs as organic material has advantages such as increasing cation exchange capacity, increasing water retention, maintaining temperature stability and increasing the availability of nutrients which are essentially needed for plant growth (Alghamdi et al., 2023).

Previous research by Giménez et al. (2020) also showed that the use of tea dregs as an additional planting medium provided significant high plant yields in lettuce and other vegetables. Although coffee grounds do not show results as good as tea dregs, their presence as organic material also plays a very important role as a source of energy and food for soil microbes so that they can increase the activity of these microbes in providing plant nutrients (Jacoby et al., 2017). Coffee grounds have a positive impact on soil quality, so that they can increase plant growth in the short term by increasing organic matter levels, soil fertility, and carbon stocks (Khan et al., 2023). Meanwhile, the mixed treatment is suspected of lacking nutrient doses caused by differences in materials so that the results are not better than single treatments.

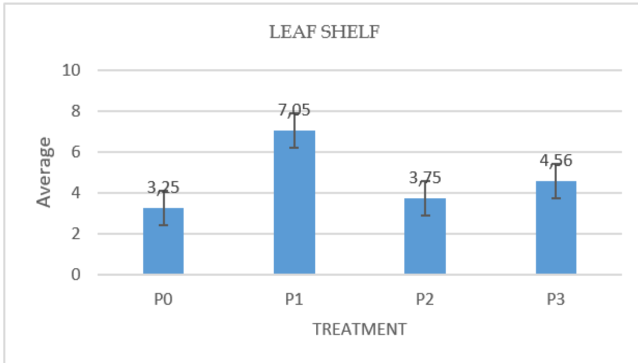

Figure 3. Average results of number of leaves

The average growth of the number of leaves was the highest in treatment P1, which was 7.06 leaves. While P0 showed the lowest results with an average of 3.25 leaves. The results obtained also showed that coffee grounds contributed to the increase in the number of leaves in mustard plants with an average of 3.75. Likewise, the treatment of a mixture of tea grounds and coffee grounds was 4.56. After data analysis, it was seen that the treatment of tea grounds and coffee grounds alone and in a mixture had a significant effect on the increase in the number of leaves where Fcount 8.757> Ftable 3.49-5.95 with a confidence level of 95%. However, after the BNT test, only P1 with the addition of tea grounds to the planting medium alone gave a significant difference from the control. Likewise, P1 was significantly different from P2 and P3, while P2 and P3 were not significantly different from P0.

Table 3. Results of ANOVA and BNT Data Analysis of the Number of Leaf Strands

Treatment	Average Treatment	P0	P1	P2	P3	BNT	F count	Ftable(0.05)
P0	3.25	a	b	a	a			
P1	7.06	b	a	b	a			
P2	3.75	a	B	a	a	1.76	8.757*	3. 49-5.95
P3	4.56	a	b	a	a			

The contribution of tea dregs to increasing the number of leaves occurs due to the decomposition of macro and micro minerals absorbed by plants. One of the nutrients provided by tea dregs is nitrogen which is included in the chlorophyll molecule which is responsible for the photosynthesis (Mandal & Dutta, 2020). In addition to providing nutrients, tea dregs that decompose in the planting medium during the observation phase contain antioxidants, flavonoids and tannins which can prevent the arrival of pests and diseases so that they have a positive effect on plants (Riddick, 2024). Pereira et al. (2024), reported the results of their research obtained the same results that the treatment of organic tea dregs had a significant effect on the number of leaves at the age of 3 MST in chili plants.

The provision of coffee dregs in the planting medium also had a positive effect on the number of leaves, although not as much as that produced by tea dregs. This happens because the nitrogen content of coffee dregs is lower than that of tea dregs. Picca et al. (2023), composed biochar and coffee grounds with a yield of 2.81% producing higher nitrogen than SNI 19-7030-2004, which is 0.40%. In addition, the provision of coffee grounds can function as a provider of Zn which has a positive effect on plant growth. Meanwhile, the mixed treatment showed results that were not better than the single treatment. This condition is the same as the observation of plant height which is influenced by the dose. However, the mixed treatment is better than the control so that the use of tea grounds and coffee grounds as organic materials is still recommended. This is in line with the research of Adi et al. (2023), which produced a greater number of pak choy plant leaves using organic planting media.

Figure 4 shows the results of measuring the root length of mustard greens (Brassica juncea L.) with the results that P0 has a root length of 7.6 cm, P1 4.8 cm, P2 4.5 cm, while in treatment P3 it is 4.3 cm. The results of the observations obtained confirmed that the provision of tea dregs and coffee dregs either singly or mixed did not contribute greatly to the elongation of plant roots.

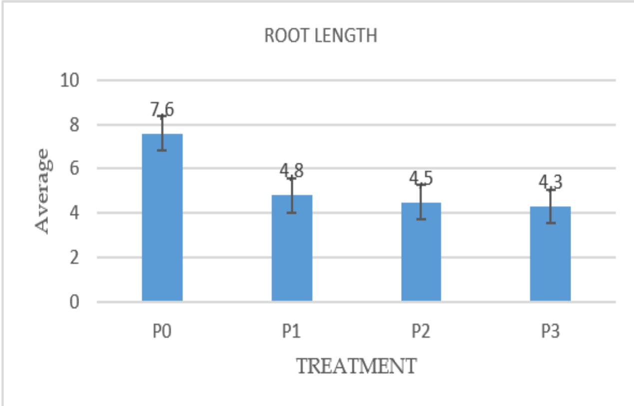

Figure 4. Average root length results

Table 4. Results of Data Analysis of ANOVA and BNT Tests Root Length

Source of diversity (SK)	Degrees of freedom (db)	Sum of squares (JK)	Middle Square (KT)	F_{count}	F_{table}
					0.05-0.01
Treatment	3	28.328	8.442	0.367	3.49-5.95
Experimental error	12	275.41	22.950		
Total	15	285.738			

The results of the data analysis showed Fcount 0.367 <Ftable 3.49-5.95 so that the administration of tea dregs and coffee dregs either singly or mixed did not show significant results on plant root growth. In fact, the control treatment showed the highest results of each treatment. According to Chevalier et al. (2025), this can occur due to the inaccuracy of the dose in the planting medium so that it tends to produce lower biomass and growth in the roots. This condition is possible due to the decomposition process and the presence of alkaloid elements that can inhibit plant growth. The same results were also obtained by Tarashkar et al. (2023), that the concentration of tea dregs waste and did not have a significant effect on plant root volume. Chemically, tea dregs and coffee dregs have many similarities in elements such as polyphenols and caffeine, although the levels are different. However, if these two elements are not processed properly or are not optimally decomposed, they can have a negative impact on plants. Tanti et al. (2016), explained that polyphenols and caffeine can interfere with embryo development which ultimately inhibits the germination process and inhibits the embryo's water absorption capacity, cell wall extensibility, and plasma membrane stiffness in a dose-dependent manner. The mechanism of nutrient availability can be through the root interception process in plants where plant roots grow and develop to occupy the space originally occupied by the absorbed nutrients (Neina, 2019). Therefore, tea and coffee grounds nutrients can be freely absorbed which are available in the planting medium.

Caffeine in tea and coffee grounds can limit root development and elongation by reducing the mitotic index, disrupting protein metabolism, and reducing protein content at the apical end of the root. Caffeine can also induce the production of large starch granules, which interfere with photosynthesis (Alkhatib et al., 2016). However, coffee grounds alone can be potentially more dangerous than tea grounds. Fresh coffee grounds (NU) stop development at the root stage (Vitale et al., 2024). Increasing soil water retention but without stimulating plant growth (Tang et al., 2024). Coffee waste with caffeic acid and chlorogenic acid, inhibits the activity of Glucose-6-phosphate dehydrogenase (G6PDH) and 6-phosphogluconate dehydrogenase (6PGHD), with adverse effects on plant metabolism (Nguyen et al., 2024). Benzoic acid in coffee inhibits germination and root and shoot growth in radishes (Vitale et al., 2024).

Conclusion

Observations of the provision of tea dregs and coffee dregs in the mustard greens planting medium obtained positive results. The provision of tea dregs singly had a significant effect on plant height (9.8 cm) and the number of leaves (7.5 leaves). The treatment of providing tea dregs also had a significantly different effect from the Control and other treatments. While coffee dregs singly contributed to plant height of 7.1 cm and the number of leaves of 3.75 where the results obtained were not significantly different from the Control and other treatments. However, overall, both single and mixed treatments did not significantly affect the length of plant roots.

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Author Contributions
Conceptualization, methodology, validation, formal analysis, investigation, resources, D., Y., A.; data curation, writing—original draft preparation, writing—review and editing, visualization, A. A., M All authors have read and agreed to the published version of the manuscript.

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Conflicts of interest
The authors declare no conflict of interest.

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