Effects of type of biochar and dolomite – coffee compost application on characteristic of soybean germination

Zamriyetti1, S Mayly2* and D Mufriah2

1Department of Agrotechnology, Faculty of Science and Technology, Pembangunan Panca Budi University, Medan, Sumatera Utara, Indonesia.
2Department of Agroecotechnology, Faculty of Agriculture, Al Washliyah Medan University, Medan, Sumatera Utara Indonesia.

E-mail: *syarifamayly@yahoo.com

Abstract. This study aimed to determine the effects from biochar types application and dolomite-coffee compost application on characteristic of soybean germination. This study used factorial randomized design with two factors and two replications. The biochar types application that were applied were no biochar, rice husk biochar, rice straw biochar. Second factor was dolomite-coffee compost application such as control, dolomite 500 kg/ha, coffee compost 10 ton/ha, dolomite 500 kg/ha + coffee compost 10 ton/ha. The parameters observed in this research were root length, shoot length, root volume, root and shoot dry weight. Result of study indicated that rice straw biochar had the highest value of soybean germination like shoot length, root volume, root and shoot dry weight compared with other biochar types application. The highest value of root volume and root dry weight were found from dolomite application. Combination rice straw biochar with dolomite application showed the highest value of soybean germination.

1. Introduction
Soybean is the third main commodity after rice and corn. Soybean as a food has a high nutritional value and the best source of protein, fat, vitamins, minerals and fibre. In 2018, total soybean harvested area and production were 680,373 ha and 982,598 tons [1]. Forecasted in 2020 that the production and consumption of soybean increase 6.80 % and 2.10 % per year respectively [2]. The average of national soybean productivity was stagnant in 1.1–1.3 ton/ha, meanwhile in 2025 the total need for soybean continues to increase at 3.35 million tons. If the average of national soybean productivity could reach 1.5 ton/ha, in 2025 the need for soybean planting area is estimated at 2.24 million ha.

National soybean production can be increased with three approaches, namely 1) increasing productivity, 2) increasing cropping intensity and 3) expanding planting area. Effort to increasing productivity of soybean can be pursued through improved varieties, used of improved varieties, improved cultivation techniques namely improving land conditions with amelioration, balanced and integrated fertilization, improving water systems and reducing yield losses through improved harvest and postharvest systems. Increasing cropping intensity by successively planting soybeans is suspected to be unfavourable because there is an allelopathic effect on the second soybean crop. Expanding planting area can be done by utilizing sub optimal (marginal) lands with a very large potential area, one of which is for lands classified as acid [3]. The potential of acid dry land for the cultivation of annual crops in North Sumatra reaches 277,623 ha in the lowlands and 87,281 ha in the highlands [4].
Biochar application can replace lime, in reducing soil acidity where the combination of biochar application (2-4%) with lime (equivalent to a dose of about 2 ton/ha lime) can significantly improve soil quality and increase plant growth [5]. Rice straw biochar + cow manure fertilizer application showed the highest value of soil pH, total N, K exchange soil compared with combination other biochar with other manure fertilizer [6-7]. Rice husk biochar + cow manure fertilizer could increase the plant height, dry matter, total leaf area, net assimilation rate, relative growth rate, pond weight per plant, seed weight per plot. Soybean germination and growth of soybean germination were depended on interaction between biochar type, doses of application, and soil type [8]. This study aimed to determine the effects from biochar types application and dolomite-coffee compost application on characteristic of soybean germination

2. Material and method
This study was conducted at simple plastic house in Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia. This study used factorial randomized design with two factors and two replications. First factor was the biochar types application such as application of no biochar, rice husk biochar, and rice straw biochar. Second factor was dolomite-coffee compost application such as control, dolomite 500 kg/ha, coffee compost 10 ton/ha, dolomite 500 kg/ha + coffee compost 10 ton/ha. The organic matter for biochar were collected from rice mill and rice field in Sei Rampah Village. The coffee compost was collected from coffee plant in Tanjung Morawa Village. Soy bean were germinated in simple root box. The root box size was 30 cm x 20 cm x 3 cm. Soil and biochar were mixed and then was put in root box. Soy bean was sown 2 seeds per hole and dolomite-coffee compost was applied into the root box. The parameters were collected from soybean germination were root and shoot length, root volume, root and shoot dry weight. The germination parameters were measured at 30 days after planting. The data analysis used for this study was Anova, and if it was had significance effect than the test will continued by Duncan Test at 95% confidence interval.

3. Result and discussion
Research result showed that type of biochar application had significant effect on shoot length but had no significant effects on shoot dry matter and all root germination parameters at 30 days after planting. The average of soybean germination growth can be seen at Table 1. The highest of root length mean values was 39.81 cm found from no biochar treatment, and the highest mean values of the other soybean germination growth were rice straw biochar application which the mean values were 47.66 cm for shoot length, 1.28 ml for root volume, 0.25 g for root dry matter and 0.78 g for shoot dry matter. The lowest mean values of root length, root volume and root dry matter were found from rice husk biochar application and the lowest values of shoot length and shoot dry matter were found from no biochar application.

| Type of Biochar      | Root Length 30 DAP | Shoot Length 30 DAP | Root Volume 30 DAP | Root Dry Matter 30 DAP | Shoot Dry Matter 30 DAP |
|---------------------|--------------------|---------------------|--------------------|------------------------|------------------------|
| No Biochar          | 39.81              | 38.41               | 0.99               | 0.25                   | 0.58                   |
| Rice Husk Biochar   | 37.69              | 43.06               | 0.78               | 0.22                   | 0.65                   |
| Rice Straw Biochar  | 37.81              | 47.66               | 1.28               | 0.25                   | 0.78                   |

Note: No significant effect (P= 0.05) if the means had the same letter in the same columns.
Table 2. Mean values of root and shoot length, root and shoot dry matter at 30 days after planting as affected by dolomite-coffee compost application

| Varieties            | Root Length 30 DAP | Shoot Length 30 DAP | Root Volume 30 DAP | Root Dry Matter 30 DAP | Shoot Dry Matter 30 DAP |
|----------------------|--------------------|---------------------|--------------------|------------------------|-------------------------|
| Control              | 38.75              | 41.63               | 1.18               | 0.24                   | 0.87                    |
| Dolomite             | 36.42              | 42.29               | 1.24               | 0.27                   | 0.69                    |
| Coffee Compost       | 40.83              | 41.50               | 0.76               | 0.23                   | 0.47                    |
| Dolomite+Coffee      | 37.75              | 46.75               | 0.89               | 0.23                   | 0.65                    |

* No significant effect (P= 0.05) if the means had the same letter in the same columns

The dolomite-coffee compost application treatment had no significant effect on all soybean germination growth parameters. The mean values of dolomite-coffee compost application on soybean germination growth can be found in Table 2. Dolomite application showed the highest mean values on root volume and root dry matter which it were 1.24 ml and 0.27 g respectively, control treatment showed the highest mean value of shoot dry weight (0.87 g), coffee compost showed the highest mean value of root length (40.83 g) and the highest of shoot length found from dolomite+coffee compost application (46.75 cm). Dolomite application treatment showed the lowest of root length and the others lowest of soybean germination growth parameters were found from coffee compost application treatment.

Figure 1. Effect between type of biochar application with dolomite-coffee compost application on root characteristic of soybean germination growth 30 days after planting

There were no significant interaction effects among the type of biochar application with dolomite-coffee compost application for all soybean germination growth parameters. The interaction effect of biochar types application with dolomite-coffee compost application on root characteristic of soybean germination growth can be seen in Figure 1. The root length of soybean from rice husk or rice straw biochar application were lower than the root length which no had biochar application for all combination with dolomite-coffee compost application except the root length from the combination of rice husk biochar with dolomite + coffee compost application treatment and rice straw biochar with coffee compost application treatment. In root volume parameter the combination rice straw biochar with dolomite application treatment or with control showed the highest root volume of the soybean and the treatment combination of rice husk biochar with coffee compost application showed the lowest root...
volume. In root dry matter parameter, the highest value was found from rice straw biochar with dolomite application meanwhile the rice husk biochar with control application showed the lowest value.

The interaction effect of biochar types application with dolomite-coffee compost application on shoot characteristic of soybean germination growth can be seen in Figure 2. The highest shoot length of soybean was found from combination rice straw biochar with dolomite + coffee compost application treatment and the lowest shoot length found from combination no biochar with coffee compost application treatment. In shoot dry matter parameter, the highest value was found from combination rice straw biochar with control application treatment.

![Figure 2](image-url)  
**Figure 2.** Effect between type of biochar application with dolomite-coffee compost application on shoot characteristic of soybean germination growth 30 days after planting

4. Conclusion

Rice straw biochar application increased soybean germination growth 30 days after except root volume compared with no biochar application, dolomite application increased root volume, root and shoot dry matter compared with dolomite + coffee compost or only coffee compost application. Rice straw biochar with dolomite application increased root and shoot length, root dry matter and volume.

References

[1] Ministry of Agriculture Republic of Indonesia 2019 *Data Lima Tahun Luas dan Produksi Tanaman Pangan 2014-2018 [Data of Five Years of Area and Production of Food Crops 2014-2018]* (Indonesia: Ministry of Agriculture)

[2] Aldillah R 2015 *Proyeksi Produksi dan Konsumsi Kedelai Indonesia [Projection of Indonesian Soybean Production and Consumption]* *Jurnal Ekonomi Kuantitatif Terapan* **8** (1)

[3] Ministry of Agriculture 2010 *Pedoman Pelaksanaan Pengembangan Kacang-kacangan dan Umbi-umbian tahun 2010 [Operating Procedure Development of Nuts and Tubers in 2010]* (Indonesia: Ministry of Agriculture)

[4] Puslitbangtanak 2001 *Atlas Arahan Tata Ruang Pertanian Indonesia, Skala 1:1.000.000 [Atlas of Direction for Indonesian Agricultural Spatial Planning, Scale 1: 1,000,000]* (Pusat Penelitian dan Pengembangan Tanah dan Agroklimate [Bogor: Center for Research and Development of Agricultural Land and Agroclimate])

[5] Berek A K, Hue N and Ahmad A 2011 *Beneficial Use of Biochar to Correct Soil Acidity* (Hawaii: University of Hawaii)
[6] Havena M and Mayly S 2015 Potensi Biochar Yang Diperkaya Pupuk Kandang Dalam Meningkatkan Kualitas Tanah Dan Hasil Kedelai [Biochar Potential Enriched with Manure in Improving Soil Quality and Soybean Results] (Medan: Universitas Pembangunan Panca Budi)

[7] Havena M and Mayly S 2016 Potensi Biochar Yang Diperkaya Pupuk Kandang Dalam Meningkatkan Kualitas Tanah Dan Hasil Kedelai [Biochar Potential Enriched with Manure in Improving Soil Quality and Soybean Results] (Medan: Universitas Pembangunan Panca Budi)

[8] Zamriyetti, Mayly S and Kamila S 2018 The Influence of Biochar Types of Soil and Dosage Soybean Substraction International Journal for Innovative Research in Multidisiplinary Field