Growth And Nitrogen Uptake of Kenikir (*Cosmos caudatus Kunth.*) Microgreens In A Combination of Manure And Biochar Planting Media

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Abstract. Microgreens are young vegetable greens that harvested when the cotyledons have fully developed, which usually occurs at the age of 7-14 days after germination. Kenikir is a medicinal vegetable plant that has many health benefits. Microgreens cultivation in Indonesia is increasing along with public awareness of health, but the information about the best planting media for the cultivation of microgreens is still very limited. This research aimed to study the effect of a combination of manure and biochar on the growth and N uptake of kenikir microgreens. The research conducted in Mojogedang, Karanganyar, Central Java using a factorial complete randomized block design (RCBD). The first factor is the type of manure consisting of control, cows, and goats. The second factor is the type of biochar consisting of husks, coconut shells, and rice straw. The results showed that the combination of manure and biochar treatment can increase plant N uptake. The combination of cow manure with various types of biochar produces the highest N uptake. Cow manure combined with husk, coconut shell and straw biochar successively produced N absorption 1.72%, 1.81% and 1.91%. However, the large uptake of N does not influence the growth of microgreens. The variety of manure did not significantly affect the growth (plant height, leaf area, and root length) of kenikir microgreens. Biochar type affects plant height. Husk biochar increases plant height by 16.29%, and coconut shell biochar increases plant height by 9.03% compared to straw biochar.

1. Introduction
Microgreens cultivation in Indonesia is increasing along with public awareness of health. Various types of vegetables, food, and flowers can be used as microgreens. Kenikir is one of Indonesia's indigenous vegetable plants that have many health benefits and able to use it as microgreens. Based on farmers information, the medium used is a mixture of biochar, manure, and soil. But information about the types of manure and biochar used is still very limited. Recent research on microgreens growing media provides alternative planting media materials from recycled textile fiber and jute kenaf fiber [1].

Plant growth is a very critical component in plant cultivation. One way to improve plant growth is by applying manure and biochar. Manure is all waste products from livestock that can be used to add nutrients [2], enhance soil physical properties [3], and biology of soil [4, 5]. Manure is one of the organic materials that can provide nitrogen to increase plant growth [6, 7].
Biochar is the result of pyrolysis burning of organic material. Biochar can improve the physical, chemical and biological properties of the soil so that it can maintain nutrients available for plants [8, 9, 10]. The primary ingredients used will affect the characteristics of biochar itself and have different effects on plant growth [11]. Biochar combined with organic fertilizer is an environmentally friendly material and can increase the availability of N in the soil to improve plant growth [12]. This research was conducted to examine the right combination of media types to produce the best growth and N uptake of kenikir microgreens.

2. Materials and method

2.1. Place and time
The study was conducted in Mojogedang, Karanganyar, Central Java. Starting from January to June 2019.

2.2. Material and tools
The materials used are kenikir seeds, cow manure, goat manure, husk biochar, coconut shell biochar, straw biochar, H$_2$SO$_4$. The instrument used was a ruler, digital balance, destilator, spectrophotometer.

2.3. Research methods
The study used a Complete Randomized Block Design (RCBD) with two factors, namely manure (P) and biochar (B). Manure consists of 3 types, with no manure (P1), cow manure (P2), and goat manure (P3). Biochar treatment consists of 3 varieties, husk biochar (B1), coconut shell (B2), and straw (B3). There were 9 treatment combinations. Each combination was repeated 3 times so that 27 experimental units obtained. Microgreens harvested at 7 days after seedling.

Growing media is made using a combination of biochar, soil, manure with a ratio of 2: 1: 1. Planting media placed in a tray (15 cm × 11 cm × 4 cm), then seeds planted in a tray with a population of 100 seeds/tray. Observations made on microgreens were plant height, leaf area, root length, and nitrogen uptake. Plant height begins to measured 3 days after seeding until harvest from the surface of the soil to the tip leaf. Leaf area was measured using the constant method. Root length is measured from the base to the tip of the roots at harvest. Nitrogen uptake was measured using the wet ashing method with H$_2$SO$_4$ at harvest. For soil analysis, organic C (Walkley & Black method), total N (Kjeldahl), CEC (NH$_4$OAc 1N pH 7.00) were carried out at the beginning of the experiment [13a].

2.4. Data processing
The data obtained were analyzed by the F test, if there were significant differences between treatments, further tests were carried out using the Duncan multiple range test (DMRT) at 5% level. Statistical analysis was performed using IBM SPSS 23.

3. Results and discussion
The planting medium physically supports the plant roots, has pores for oxygen exchange/root respiration and water storage, also supplying mineral nutrients to plant roots. Organic C content, total N, and CEC planting media included in the very high category [13b]. The most leading organic C produced from a combination of control and husk biochar with 26.34%. The most leading total N delivered from a combination of goat manure and biochar straw (1.59%). The highest CEC produced from a combination of cow manure and coconut shell biochar (69.00%).
Table 1. Media properties

| Treatment | Organic C (%) | Total N Kjedhal (%) | CEC (me %) |
|-----------|---------------|----------------------|------------|
| P1B1      | 26.34         | 0.95                 | 60.00      |
| P1B2      | 24.08         | 1.09                 | 60.15      |
| P1B3      | 26.01         | 1.22                 | 63.30      |
| P2B1      | 23.37         | 1.16                 | 65.30      |
| P2B2      | 24.93         | 1.20                 | 69.00      |
| P3B1      | 21.51         | 1.32                 | 66.30      |
| P3B2      | 22.13         | 1.44                 | 67.70      |
| P3B3      | 22.52         | 1.59                 | 65.90      |

3.1. The Effect of Manure and Biochar on the Growth of Kenikir Microgreens

Based on table 2 below, the type of manure does not significantly affect plant growth. This is due to all manure treatments have organic C, total N, and CEC that can meet the nutritional needs of plants. Furthermore, plants at the stage of microgreens do not require large amounts of nitrogen.

Biochar has a significant effect on plant height (Table 2). The best kenikir microgreens were produced in the treatment of husk biochar but were not significantly different from coconut shell biochar. At the age of 7 days after seeding (DAS), biochar husk increased plant height by 16.29%, and biochar coconut shell increased plant height by 9.03% compared to straw biochar. [14] stated that the addition of biochar to the planting medium roled as a soil enhancer for chemical properties of the soil (pH, cation exchange capacity, total N, available P, and Al deferred), also improve physical properties of the soil (bulk density, porosity and the ability of the soil to hold water). Improving the quality of the chemical and physical properties of the soil affects the availability of nutrients and water through the ability of biochar to increase plant growth.

The lowest plant height produced in biochar straw shown in table 2. However, Nitrogen and CEC values among biochar types still included in the high category (Table 1). The below plant height is suspected to be the surface area of the biochar pores of straw is lower than other treatments [15, 16]. This makes the planting medium porosity is low then difficult to absorbing and releasing water. In these conditions, plant respiration is disrupted thereby reducing plant growth.

Table 2. The Effect of Manure and Biochar on the growth of Kenikir microgreens

| Treatment | Plant height (cm) | Leaf area (cm²) | Root length (cm) |
|-----------|-------------------|-----------------|------------------|
|           | 4 DAS  | 5 DAS  | 6 DAS  | 7 DAS  |           | 4 DAS  | 5 DAS  | 6 DAS  | 7 DAS  |
| Manure    |         |        |        |        |           |        |        |        |        |
| P1        | 4.46a   | 5.51a  | 6.73a  | 7.07a  | 0.97a    | 6.58a  |        |        |        |
| P2        | 3.95a   | 4.55a  | 5.76a  | 6.38a  | 0.91a    | 6.53a  |        |        |        |
| P3        | 4.47a   | 5.18a  | 6.40a  | 6.72a  | 0.98a    | 6.68a  |        |        |        |
| Biochar   |         |        |        |        |           |        |        |        |        |
| B1        | 4.64b   | 5.65b  | 6.89b  | 7.21b  | 0.97a    | 6.93a  |        |        |        |
| B2        | 4.32ab  | 5.15ab | 6.35ab | 6.76ab | 0.95a    | 6.70a  |        |        |        |
| B3        | 3.91a   | 4.45a  | 5.65a  | 6.20a  | 0.94a    | 6.17a  |        |        |        |

The number followed by the same letters on the same column are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level

3.2 The Effect of Manure and Biochar on Nitrogen Uptake of Kenikir microgreens

Table 3 shows that cow manure produces higher N uptake than goat manure and without manure when combined with various types of biochar. In the combination of biochar husk with manure, cow manure produced the highest N uptake (1.72%) but was not significantly different from goat manure (1.56%).
In the combination of coconut shell biochar, cow manure produced the highest N uptake (1.81%) compared to other treatments. In the combination of biochar straw, cow manure produced the highest N uptake (1.91%) compared to other treatments. This is expected to cow manure having crumb texture, so it is easily degraded and decomposed, resulted in faster nutrients uptake. [17] states that the duration of the decomposition process in manure affected by the texture of the manure itself. The texture like grains and dense rather difficult to detach physically, so it is slow to decompose, and the availability of nutrients cannot be uptake by plants. [18] stated that the application of green manure and biochar affects the availability of N in the soil and increases the efficiency of N uptake.

Table 3. The combination effect of manure and biochar types on N uptake

|                | B1 (husk biochar) | B2 (coconut shell biochar) | B3 (straw biochar) |
|----------------|------------------|---------------------------|-------------------|
| P1 (without manure) | 1.05<sup>a</sup> | 1.04<sup>a</sup>          | 1.13<sup>ab</sup> |
| P2 (cow manure)    | 1.72<sup>de</sup> | 1.81<sup>de</sup>         | 1.91<sup>c</sup>  |
| P3 (goat manure)   | 1.56<sup>cd</sup> | 1.28<sup>abc</sup>        | 1.38<sup>bc</sup> |

The number followed by the same letters on the same column and row are not significantly different according to Duncan Multiple Range Test (DMRT) at 5% level

3.3 Correlation of Growth Parameters for Kenikir microgreens

Based on table 4, there are positive correlations on several observed parameters. The increase in total N planting media followed by an increase in CEC planting media, and N uptake of plants. The CEC has a role in maintaining soluble ions and Nitrogen in planting media so that it is available to plants [19]. However, the increase in N uptake did not express the character of plant growth (plant height, leaf area, and root length). The high Nitrogen uptake is thought to manifest in the chlorophyll. [20] state that manure is a good source of nitrogen for plants. Nitrogen is biologically combined with C, H, O, and S to form amino acids, which are the main ingredients of protein synthesis. Amino acids play an essential role in plant growth and development, also involved in all enzymatic reactions in plants. Nitrogen is a fundamental constituent of the chlorophyll molecule and required in photosynthesis. Research [21] affirmed that nitrogen significantly affected chlorophyll content in leaves and stems. Organic C has a negative correlation with some observed parameters. An increase in organic C, followed by a decrease in nitrogen, CEC, and plant N uptake.

Table 4. Coefficient correlation between observed variables

|    | C   | N   | CEC  | T1  | T2  | T3  | T4  | LD  | PA  | SN  |
|----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|
| C  | 1   |     |      |     |     |     |     |     |     |     |
| N  | -0.725** | 1   |      |     |     |     |     |     |     |     |
| CEC | -0.368* | 0.542** | 1   |     |     |     |     |     |     |     |
| T1 | 0.224 | -0.341 | -0.262 | 1   |     |     |     |     |     |     |
| T2 | 0.256 | -0.339 | -0.209 | 0.958** | 1   |     |     |     |     |     |
| T3 | 0.258 | -0.343 | -0.214 | 0.961** | 0.999** | 1   |     |     |     |     |
| T4 | 0.214 | -0.343 | -0.137 | 0.850** | 0.897** | 0.893** | 1   |     |     |     |
| LD | -0.023 | -0.023 | -0.104 | 0.435* | 0.418* | 0.399* | 0.364 | 1   |     |     |
| PA | 0.237 | -0.164 | 0.157 | -0.031 | -0.027 | -0.020 | 0.138 | -0.118 | 1   |     |
| SN | -0.524** | 0.415* | 0.549** | -0.258 | -0.357 | -0.355 | -0.342 | -0.161 | -0.203 | 1   |

Note: C: C organic, N: Nitrogen total, CEC: Cation Exchange Capacity, T1: Plant height 4 DAS, T2: Plant height 5 DAS, T3: Plant height 6 HSS, T4: Plant height 7 DAS, LD: Leaf area, SN: N uptake.

4. Conclusion

The type of manure does not significantly affect growth (plant height, leaf area, root length) of kenikir microgreens. Biochar type treatment impacts plant height. The best plant height is presented from husk biochar, but not significantly different from coconut shell biochar. The combination of manure and biochar treatment can increase plant N uptake. The combination of cow manure with various types of
biochar produces the highest N uptake. However, the high uptake of Nitrogen does not affect the growth of microgreens.

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