The effect of biochar dose and NPK fertilizer on the production and growth of pak choi plant

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Abstract. Pak choi is a leaf vegetable plant that has a high economic value. To improve the quality of marginal soils, soil conditioners need to be given, one of which is bio charcoal (biochar) and NPK fertilizer. The experiment was done using randomized block design method, with two treatment factors and three replications. The first factor was biochar dose (0, 10 and 20 tons/Ha), and the second one was NPK fertilizer dose (0, 150, 300, and 450 Kg/Ha. The parameters to be measured were: plant height, number of leaves, wet and dry weight of the plant, and root dry weight and volume. The results showed that both biochar dose, NPK dose and the interaction between the two factors had no significant effect on the growth and production of pak choi.

Keywords: Pak choi, NPK fertilizer, biochar

1. Introduction
Pak choi is a leaf vegetable plant belonging to the Brassicaceae family and comes from China. The cultivation of this plant is growing rapidly in subtropical and tropical regions [1]. The vegetable has many advantages, including high productivity, short harvest time (25 -50 days after planting), wide adaptability (not sensitive to temperature changes), and the quality of the product is durable because it can be stored up to 10 days after harvesting at a temperature of 0- 5°C with 95% humidity. Each of 100 g of fresh pak choi contains 92.2% water, 3.9% carbohydrates, 1.8% protein, 0.7% fiber and 0.9% ash [2]. Pak Choi also contains vitamins and minerals such as ß-carotene, vitamin C, Ca, P and Fe [3].

One of the main factors that determine the success of cultivation is the planting medium used. To make the fertile and loose soil, it can be accomplished by giving soil enhancers namely organic material from agro-industrial waste or known as biochar. Soil enhancers play a crucial role in increasing soil CEC, improving soil structure, storing water, and as a good habitat for the development of various microbes [4,5]. Biochar of porous wood, when it is used as soil enhancers, so it will provide habitat for soil microbes, but not to be consumed. Biochar does not impair the carbon-nitrogen balance for a long time, but it can hold water and make the nutrients more available for plants. When it is used with organic and inorganic fertilizers, biochar can increase the retention and availability of nutrients for plants. The application of biochar to the soil is considered as a new and unique approach to make a sink (sink) for air CO2 for a long time on terrestrial ecosystems [6].

From the results of the study [7,8], it can be concluded that by giving 6% biochar (90 g biochar + 1410 g soil), it could be increase the height, leaf area, and stem diameter of the plant, but does not affect the number of roots, root length, and wet weight of palm oil seeds. Based on the results of the study [9], soil that was treated with 10 tons of biochar per hectare can increased soil pH and rice grain production. The use of compound fertilizers, can increased the efficiency of fertilizer use, so the costs are not too expensive. NPK fertilizer is a compound fertilizer containing elements of nitrogen,
phosphorus and potassium. The compound fertilizer that is often used is NPK fertilizer. The use of NPK fertilizer is expected to provide ease of application in the field and can increase the nutrient content that needed in the soil and it can be used directly by plants [10-12]. From the results of the study, [13] it can be concluded that by giving NPK fertilizer 400 Kg/Ha can increased the production of rice from 0.3 to 1.6 tons / Ha. Based on the results of the study [14,15], the given of NPK fertilizer 300 Kg/Ha red curly chili can increased plant height, number of flowers, number of fruit, and weight of fruit for each plants. This study aims to determine the effect of biochar dose and NPK fertilizer on the production and growth of pak choi plants.

2. Methods
This research used factorial randomized block design (RBD), with two treatment factors, namely biochar dose (B) and NPK fertilizer (P). Biochar dose consisted of 3 levels, namely: B0 is 0 ton/Ha (control), B1 is 10 ton/Ha (25 g/polybag), and B2 is 20 ton/Ha (50 g/polybag). The dosage of NPK fertilizer consisted of 4 levels, namely, P0 is 0 Kg/Ha (control), P1 is 150 Kg/Ha (0.375 g/polybag), P2 is 300 Kg/Ha (0.750 g/polybag), and P3 is 450 Kg/Ha (1.125 g/polybag). Thus, 12 treatment combinations were obtained, and each of them was repeated 3 times, so that there were 36 research units. Each of research unit consisted of 3 polybags, and each of them planted with one pak choi plant, so there were 108 pak choi plants. At each unit a random sample plant was determined, so that there were 36 sample plants. The placement of each research units in the planting block was set randomly.

3. Results and discussion
From the results of the study, it can be seen the influence of biochar dose treatment and NPK fertilizer on plant height and the number of leaves of pak choi plants as in Table 1. Table 1 showed that plant height which was given by Biochar was not significantly different from those not given by Biochar. It was caused og Biochar given that was influenced by the type and Biochar dose used. At the Biochar dose treatment age 7 MST, the highest plants found in B2 treatment that was not significantly different from other treatments. At biochar dose treatment aged 6 MST, the highest number of leaves found in
B0 treatment that was not significantly different from other treatments. Whereas in the treatment of NPK fertilizer dose at age 7 MST, the highest plants found in P3 treatment that was not significantly different with P2 treatment but were significantly different from treatment P0 and P1. In the treatment dose of NPK fertilizer aged 7 MST, the highest number of leaves found in P3 treatment that was significantly different from the treatment P0, P1 and P2.

**Table 1.** The effect of treatment of biochar dose and npk fertilizer on plant height and number of leaves of pak choy plants.

| Parameter       | Treatment | 2 WAP | 3 WAP | 4 WAP | 5 WAP | 6 WAP | 7 WAP |
|-----------------|-----------|-------|-------|-------|-------|-------|-------|
| Height (cm)     | P0        | 5.14a | 8.24a | 10.47a | 12.36a | 16.33a | 17.67a |
|                 | P1        | 5.76b | 9.97b | 12.79b | 15.60b | 20.83b | 24.79b |
|                 | P2        | 7.00c | 11.98c | 14.34c | 17.56c | 24.43c | 27.83c |
|                 | P3        | 7.87d | 13.84d | 15.43d | 18.62d | 24.93c | 28.06c |
| Number of Leaves (sheet) | P0   | 4.56 | 5.89a | 7.67a | 9.89a | 11.78a | 12.78a |
|                 | P1       | 4.89 | 6.22a | 8.22ab | 10.56a | 12.56ab | 14.44b |
|                 | P2       | 4.89 | 7.00b | 8.78bc | 11.33b | 12.89b | 15.11b |
|                 | P3       | 4.89 | 7.00b | 9.00c | 12.00b | 14.11c | 16.00c |
| BNJ0.05         | -        | -    | -    | -    | -    | -    | -    |

**Table 2.** The effect of treatment of biochar dose and npk fertilizer on wet weight plant, dry weight plant, wet weight root, dry weight root, and pak choy plant root volume

| Treatment | Wet Weight Plant (g) | Plant Dry Weight (g) | Wet Weight Root (g) | Root Dry Weight (g) | Root Volume (ml) |
|-----------|----------------------|----------------------|---------------------|---------------------|------------------|
| B0        | 186.50               | 16.36                | 186.50              | 16.36               | 3.73             |
| B1        | 190.77               | 16.76                | 190.77              | 16.76               | 3.68             |
| B2        | 183.55               | 16.90                | 183.55              | 16.90               | 3.71             |
| BNJ0.05   | -                    | -                    | -                   | -                   | -                |
| P0        | 186.50               | 16.36                | 186.50              | 16.36               | 3.73             |
| P1        | 190.77               | 16.76                | 190.77              | 16.76               | 3.68             |
| P2        | 183.55               | 16.90                | 183.55              | 16.90               | 3.71             |
| P3        | 183.55               | 16.90                | 183.55              | 16.90               | 3.71             |
| BNJ0.05   | -                    | -                    | -                   | -                   | -                |

Then photosynthesize was translocated of new plant organs including plant leaves, (c) it stated that the relationship between the wet weight of the plant and the dose of NPK fertilizer was positive quadratic. The given of NPK fertilizer dose up to 0.99 g/polybag resulted in a maximum wet weight of 250.84 g. Providing NPK fertilizer of 0.99 g/polybag could increase the supply of elements of nitrogen, phosphorus, and potassium in the soil, so that the plant growth be more increase. The enhancement of wet weight of plants was caused by the enhancement number of leaves and stems. Stem growth and increasing number of leaves would increase the wet weight of the plant. Plant growth was done through metabolic process, then water, carbon dioxide, and inorganic salts were changed into food reserves in the presence of photosynthesis [17,18], (d) it expressed that the relationship
between dry weight of plant and NPK fertilizer dose was positive linear.

The higher of the dose of NPK fertilizer that was given, thus the dry weight of pak choi plant became heavier. The given of the dose of NPK fertilizer to 1.125 g/polybag, so it increased the dry weight of pak choi plant. The elements of nitrogen, phosphorus and, potassium were essential nutrients. These elements were needed in large quantities as fertilizer. According to an expert [19], plant growth would be inhibited, if the elements of nitrogen, phosphorus, and potassium were not available. It was supported by the opinion [20] which stated that the high and low dry weight of plants depends on the amount or minimum of nutrient during the plant growth process, (e) stated that, the relationship between the wet weight of plant roots and the dose of NPK fertilizer was positively quadratic.

Providing NPK fertilizer as much as 0.94 g / polybag produced a root wet weight of 18.52 g. To reach the needs of plants, fertilization must be carried out which aims to provide nutrients in an enough balanced amount. According to an expert, [21] the plant would grow well, if the elements were enough and relevant to the needs of the plant and (f) stated that, the relationship of dry weight to the dose of NPK fertilizer was linear positive. The higher of the dose of NPK fertilizer, the dry weight of pak choi root became increase. The enhancement of the dose of NPK fertilizer would increase the availability of nutrients N, P, and K, as a constituent of compounds in plants that would be changed to form carbohydrates which were constituents of plant dry materials [22-24] stated that, the availability of nitrogen, phosphorus, and potassium which was optimal for plants could increase the amount of chlorophyll. Chlorophyll would increase photosynthetic activity that produced assimilate and supported the dry weight of the root.
Figure 2. (a) Pak choi plant high relation with NPK fertilizer dose at 7 after planting weeks, (b) relationship of pak choi plant leaves with dosage of NPK at 7 after planting weeks, (c) wet weight of pak choi plant with dose of NPK fertilizer, (d) pak choi plant dry dot relationship with dosage of npk fertilizer, (e) relationship of wet weight root of pak choi plant with dosage of NPK fertilizer and (f) relationship of dry weight of pak choi plant root with NPK fertilizer dose.

Figure 2 stated that the relationship of plant root volume with NPK fertilizer dosage was positive linear. The higher of the dosage of NPK fertilizer, thus the volume of pak choi plant roots be higher. The given of NPK fertilizer would increase phosphorus supply in pak choi plants. According to [25], phosphorus plays a crucial role in photosynthesis and respiration so it was very important for overall growth. In addition phosphorus plays a crucial role in improving the plant root system. The growth and the branching of root could be aroused if the concentration of nutrients in the soil (especially N and P) was quite large.

The correlation between parameters observed due to the influence of biochar dose treatment and NPK fertilizer can be seen in Table 3.

Table 3. Interview Correlations Observed

| Parameter | PH | NL | WWP | DWP | WWR | RDW | RV |
|-----------|----|----|-----|-----|-----|-----|----|
| PH        | 1  |    |     |     |     |     |    |
| NL        |    | 0.97* | 1 |     |     |     |    |
| WWP       | 0.98* |     | 1 |     |     |     |    |
| DWP       | 0.98* | 0.97* | 0.99* | 1 |     |     |    |
| WWR       | 0.98* | 0.96* | 0.99* | 0.98* | 1 |     |    |
| RDW       | 0.94* | 0.93* | 0.93* | 0.96* | 0.90* | 1 |    |
| RV        | 0.98* | 0.95* | 0.97* | 0.99* | 0.96* | 0.97* | 1 |

Note: r0.05 = 0.58
PH = Height Plant WWR = Wet Weight of Roots
NL = Number of Leaves RDW = Root Dry Weight
WWP = Wet Weight of the Plant RV = Root
Volume DWP = Dry Weight of the Plant

From the Table 3, it can be seen that there was a real positive correlation between each observed parameter. It means that an enhancement in one of the plant parameters would be followed by an enhancement in other parameters. The enhancement of plant height would be followed by an enhancement in the number of leaves, the wet weight of plants and roots. The leaves were a place of plant photosynthesis. Enhancement of the number of leaves would increase the rate of photosynthesis, as a means to carry out photosynthesis were increasing. Enhancement of photosynthesis would increase photosynthate, then used by plants to produce new plant organs, especially the leaves and roots of plants.

4. Conclusion
The given of Biochar had no significant effect on the production and growth of pak choi plants. Providing NPK fertilizer of 1,125 g / polybag could increase the production and growth of pak choi plant. The interaction between Biochar dose and NPK fertilizer did not affect the production and growth of pak choi plants.

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