Combine organic and inorganic fertilizer increases yield of cucumber (Cucumissativus L.)

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Abstract. The aim of this study is to determine the effect of combine organic fertilizer (manure) and inorganic fertilizer (NPK and Micro fertilizer) on the growth and yield of cucumber (Cucumissativus L.). This study was conducted in the Experimental station, Agriculture Faculty, Universitas Syiah Kuala, Aceh from February to April 2018. This experiment was arranged in a factorial randomized completely block design with two factors and three replications. The first factor was the provision of organic fertilizer (manure) with 3 levels: 10 t ha⁻¹ (K₁), 20 t ha⁻¹ (K₂), and 30 t ha⁻¹ (K₃). The second factor was the provision of inorganic NPK fertilizer with 3 treatments: Without NPK fertilizer (control - N₀), NPK Fertilizer(N 50 kg ha⁻¹, P₂O₅ 50 kg ha⁻¹, and K₂O 50 kg ha⁻¹ (280 kg ha⁻¹Phonska 16-16-16 - N₁), and NPK + Micro Fertilizer (N 50 kg ha⁻¹, P₂O₅ 50 kg ha⁻¹, and K₂O 50 kg ha⁻¹ (280 kg ha⁻¹Phonska 16-16-16 + 2% Micro fertilizer – N₂)). Results show that organic fertilizers (20 and 30 ton ha⁻¹) increase fruit weight of each sample and fruit weight of each plant. The application of NPK + Micro Fertilizer produces in the best fruit weight of each sample and fruit weight of each plant. The combination of organic fertilizer (20 ton ha⁻¹) and inorganic NPK + Micro Fertilizer results in the best fruit weight each plant of cucumber.

1. Introduction
Cucumber (Cucumissativus L.) is a member of the cucurbitaceae family and is an important type of vegetable for consumption [1]. Cucumber plants originate from the Asian continent, precisely North Asia, although some experts suspect they are from Asia. In Indonesia, cucumber plants are planted in the lowland and highlands from 0-1000 meters above mean sea level. Cucumbers have been grown in Indonesia for food and medicinal purposes, and they have long been part of the diet. The area that are the center of Cucumber planting in Indonesia are West Java, Aceh, Bengkulu, East Java, and Central Java.

Cucumber Productivity in Indonesia is still considered low. Directorate General of Horticulture [2] states that Indonesia produced cucumber 424,918 ton in 2017 with average productivity is only 10.67 ton/ha. The low productivity is caused by the several environmental factors, one of them is the availability of nutrients in the soil. The use of inorganic fertilizers continuously to increase the soil fertility, unfortunately results significantly negative affects to the physical, chemical and biological properties of the soil.

The tendency of farmers to use inorganic fertilizer because it is more practical. High prices and costs on the use of inorganic fertilizers are often associated with reducing crop yields, soil degradation, nutrient imbalances and soil acidity, so they are not yet helpful under intensive...
agriculture [3]. In daily practice, fertile soils are used to cultivate cucumber. Infertile soil results in bitter and malformed fruits which are often rejected by consumers. To increase soil productivity and restore soil fertility in the tropics can be done by cultivating land that has been in fallow to produce a balanced and sustainable agricultural system [4]. However, this practice causes farmers loss opportunities in resulting other plants yield for their income.

Nutrient recycling and use of physical soil attributes by using organic fertilizers can support a better planting system [5]. The main raw material for organic fertilizer can be in the form of crop residues and animal waste. This organic fertilizer can showed positive results especially in long-term experiments [6]. [7] Based on the results described above, it shows the significance of organic fertilizers on the trend of diverse yields in soil and planting systems and the tendency of positive yielding trends may be due to a gradual increase in soil organic carbon (SOC) and soil physical properties.

Inorganic fertilizers result strong influence on plant growth, development and yield [8]. Ponska fertilizer is a compound fertilizer that contains elements N, P, and K. It is easily soluble in water and can increase crop production and quality, stimulate root growth, flower formation, speed up the harvest, make the stem strong and reduce the risk of falling, enlarge the size of fruit and seeds [9]. Amidst the upcoming and almost little information about the nutrient requirements of this plant, it is important to find out the effect combine organic and inorganic fertilizer to increases the yield of Cucumber.

2. Materials and Methods
The research was conducted from February to April, 2018. The Field is located in Sektor Timur experiment garden, Faculty of Agriculture, Universitas Syiah Kuala. The first step of the research was land preparation. Soil is cultivated and create beds with a size of 2.4 m x 2.4 m. The distance between beds was 50 cm, then manure was applied in accordance with the treatment, namely K1 (manure 5.76 kg each bed), K2 (11.52 kg each bed), and K3 (17.28 kg each bed). The organic fertilizer was provided one week before planting. The cucumber seeds planted with spacing 60 cm x 60 cm. Inorganic fertilizer treatments were without NPK fertilizer (control - N0), NPK Fertilizer (N 50 kg ha\(^{-1}\), P\(_2\)O\(_5\) 50 kg ha\(^{-1}\), and K\(_2\)O 50 kg ha\(^{-1}\) (280 kg ha\(^{-1}\)Phonska 16-16-16 - N\(_0\)), and NPK + Micro Fertilizer (N 50 kg ha\(^{-1}\), P\(_2\)O\(_5\) 50 kg ha\(^{-1}\), and K\(_2\)O 50 kg ha\(^{-1}\) (280 kg ha\(^{-1}\)Phonska 16-16-16 + 2\% Micro fertilizer – N\(_2\)). The fertilizers were applied in three times (1/3 each), i.e. at planting time with a NPK dose = 161.28 g; at 7, 14, 21 and 28 days after planting by being leaked; and at 37 and 44 days after planting by being leaked. Micro fertilizer is given once a week at 2\% concentration. At each bed, four sample plants that are not edge plants were analyzed. The parameters include fruit diameter, fruit length, fruit weight each sample and fruit weight each plant.

3. Results and Discussion
The results of the application of combine organic and inorganic fertilizers on the growth and yield of cucumber plants are described in Table1. Fruit length, fruit weight of each sample and fruit weight of each plant resulted from the treatment of organic fertilizer at a dose of 20 tons ha\(^{-1}\) and 30 tons ha\(^{-1}\) showed significantly better characteristic of yield than those of organic fertilizer at a dose of 10 tons ha\(^{-1}\). It is suspected that the provision of organic fertilizer at 20 tons ha\(^{-1}\) provided nutrients in a positive manner for the plants. Organic fertilizers release nutrients slowly and regularly and activate soil microbial biomass. The availability of nutrients in the soil allows the growth and production of plants to take place properly [10]. The plant growth and production was determined by the rate of photosynthesis which was influenced by nutrient availability. Unproperly nutrients supply to the plants can cause photosynthesis process to be ineffective, result in reducing of the amount of photosynthate to be transplanted to the fruit, furtherly decrease the fruit weight and quality [11].
Table 1. Cucumber fruit length, fruit diameter, fresh fruit weight/sample and fresh fruit weight/plant at different dosage of organic and inorganic fertilizers

| Treatments                  | Fruit Length (cm) | Fruit Diameter (mm) | Fruit Weight/sample (g) | Fruit Weight/plant (g) |
|-----------------------------|-------------------|---------------------|-------------------------|------------------------|
| 1 Organic Fertilizer(ton/ha)|                   |                     |                         |                        |
| 10                          | 23.20 a           | 51.13               | 452.8 a                 | 2489.3 a               |
| 20                          | 24.86ab           | 53.11               | 484.3 b                 | 2656.3 b               |
| 30                          | 25.09 b           | 53.59               | 504.4 b                 | 2773.0 b               |
| BNJ (0.05)                  | 1.82              | -                   | 21.20                   | 118.0                  |
| 2 InorganicFertilizer       |                   |                     |                         |                        |
| Without NPK                | 24.01             | 51.43               | 462.9 a                 | 2548.4 a               |
| NPK Fertilizer             | 24.38             | 53.01               | 481.9 ab                | 2637.6 ab              |
| NPK + Micro Fertilizer     | 24.76             | 53.39               | 496.7 b                 | 2732.7 b               |

Note: The numbers followed by the same letters in the same line and the same row are not significantly different in $P<0.05$.

Fruit weight of each sample and fruit weight of each plant showed the same effect on inorganic fertilizer treatments where the use of NPK + micro fertilizers produced fruit weight each sample and fruit weight each plant were significantly higher yield than without NPK, though it did not resulted in significantly higher yield than NPK fertilizer. This is presumably because the treatment of NPK fertilizer and NPK + micro fertilizers provide phosphorus and potassium nutrients that are appropriate to the needs of cucumber plants for fruit formation. [12] stated that the size and quality of fruit in the generative phase will be influenced by the availability of nutrients K, while P played a significant role in the formation of flowers and fruit for plants. The application of NPK + micro fertilizer resulted in the best yield on the character of fruit weight/sample and fruit weight each plant. This was in accordance with the results of [12], which stated that the administration of micro fertilizers + inorganic fertilizers provided a positive effect on increasing the fresh weight of cucumbers. This was thought to be related to the presence of nutrients which become a limiting or excess factor. The excess of a nutrient in soil could interfere with plant growth, through: increasing competition in absorption of nutrient with other essential elements, inactivating enzymes, replacing essential elements from their function or changing the structure of water [14].

Table 2. Interaction between different dosage of organic fertilizer and inorganic fertilizer on mean of cucumber fresh fruit weight of each sample (g)

| Organic Fertilizer            | Inorganic Fertilizer |
|-------------------------------|----------------------|
|                                | 10 ton ha$^{-1}$     | 20 ton ha$^{-1}$   | 30 ton ha$^{-1}$ |
| Without NPK                   | 463.3 Aa             | 449.5 Aa           | 475.8 Aa         |
| NPK Fertilizer                | 450.2 Aa             | 529.1 Bb           | 510.8 Bab        |
| NPK + Micro Fertilizer        | 445.0 Aa             | 474.2 Aa           | 526.5 Bb         |

Note: The numbers followed by the same uppercase letters in the same line and the same lowercase letters in the same row are not significantly different in $P<0.05$; HSD (0.05) = 50.59.

Significant response from the parameters evaluated such as the number of fruits per plant, fruit weight of each plant, fruit length and fruit diameter and the results of the application of NPK + micro fertilizer may be an indication that nutrients absorbed by plants are utilized properly in cell multiplication, amino acid synthesis and energy formation so that the process of photosynthesis increases. The results of the photosynthesis process will then be translocated to the sink. This was in consonance with the findings of [15] who reported that there was a significant response to the application of inorganic fertilizers from the weight of the cucumber each plant and the total yield. This
According to the results of the study [17], the use of inorganic fertilizers to improve the growth and yield of two cucumber varieties was confirmed.

The weight of fresh fruit each sample in all combinations of organic fertilizer and inorganic fertilizer treatments was not significantly different at a dose of 10 tons ha\(^{-1}\) of organic fertilizer. However, the weight of fresh fruit each sample in the combination of phonska treatment and 20 tons ha\(^{-1}\) of organic fertilizer was significantly higher than in the combination without fertilizer. It is suspected that the provision of organic and inorganic fertilizers has a positive role in providing nutrients for plants. The availability of nutrients in the soil allows the growth and production of plants to take place properly. The weight of cucumber is strongly influenced by the rate of photosynthesis. If the availability of water, nutrients, and sunlight is reduced, it will affect the rate of photosynthesis which will then result in a decrease in production of a plant [11].

Table 3. Interaction between different dosage of organic fertilizer and inorganic fertilizer on mean of cucumber fresh fruit weight each plant (g)

| Inorganic Fertilizer | Organic Fertilizer | 10 ton ha\(^{-1}\) | 20 ton ha\(^{-1}\) | 30 ton ha\(^{-1}\) |
|---------------------|-------------------|------------------|-----------------|-----------------|
| Without Fertilizer  | 2,549.9Aa         | 2,473.8Aa        | 2,621.6Aa       |
| NPK Fertilizer      | 2,480.0Aa         | 2,917.3 Bb       | 2,800.7 Ba      |
| NPK + Micro Fertilizer | 2,438.1Aa      | 2,577.9Aa        | 2,896.7 Ba      |

Note: the numbers followed by the same uppercase letters in the same line and the same lowercase letters in the same row are not significantly different in \(P<0.05\); HSD (0.05) = 281.8

The weight of fresh fruit each plant in all combinations of treatment without fertilizer is not significantly different in a dose of organic fertilizer 10 tons ha\(^{-1}\). However, the combination treatment of NPK and organic fertilizer in a dose of 20 tons ha\(^{-1}\) showed better weight each plant which was significantly different from other combinations. The combination of NPK + micro fertilizer showed better fresh fruit weight each plant with organic fertilizer at a dose of 30 ton ha\(^{-1}\), but not significantly different from the NPK fertilizer.

![Figure 1](image1.png)  
![Figure 2](image2.png)

**Figure 1.** Interaction between dosage of organic fertilizer and inorganic fertilizer treatment on mean fresh fruit weight/sample and mean fresh fruit weight of each plant

This was due to the nutrient content found in different plant growth media, so that it affected the ability of plants to absorb nutrients. In cucumber plants, after flowering, fruit formation required the
elements or substances that was sufficient in accordance with the activities of intensive exchange of the interests of various physiological processes, therefore, to support their important activities it was necessary to fertilize (provision of nutrients) according to their needs [18].

The excessive use of nitrogen fertilizer in crop cultivation can cause an increase in nitrates in plants and cause ground water pollution. Based on research results show that compost application can increase the accumulation of C, N and organic phosphorus better than using mineral N fertilizer alone. The use of compost combined with the addition of N fertilizer is the best way to improve soil fertility, the quality of cucumber yield and reduce the cost of N mineral fertilizers [19].

4. Conclusion
Based on the results of the study, it concluded that: 1) Organic fertilizers (20 and 30 ton ha\textsuperscript{-1}) increase fruit weight of each sample and fruit weight of each plant 2) the application of NPK + micro fertilizer produced better fruit weight of each sample and fruit weight of each plant; and 3) combination of NPK + micro fertilizer and organic fertilizer at a dose of 30 tons ha\textsuperscript{-1} showed the best fruit weight of each sample.

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