

Research Article**EFFECTS OF ORGANIC FERTILIZER DOSE AND SHOOT PRUNING ON THE QUANTITY AND QUALITY OF THE PRODUCT OF CUCUMBER (*CUCUMISSATIVUS L.*)****Widiwurjani, *Juli Santoso and Salsabila Mulianti**

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Abstract

Increasing the quantity and quality of cucumber plants can be done through fertilizing and shoot pruning. The right dose can help fulfill the nutritional needs of plants and shoot pruning causes the distribution of nutrients provided by fertilizer to be more focused on the development of generative organs. The design used a split plot design (SPD) 2 factors, namely the dose of organic fertilizer as a sub plot and shoot pruning as the main plot. The treatment doses of organic fertilizer were 30 kg ha⁻¹ (D1), 35 kg ha⁻¹ (D2), 40 kg ha⁻¹ (D3) and 45 kg ha⁻¹ (D4). Meanwhile, the shoot pruning treatments were without shoot pruning (P0), shoot pruning the 15th segment of main stem (P1), and shoot pruning the 20th segment of main stem (P2). Data analysis using Anova and continued with Tukey Test 5%. The research did not produce interaction between the combination of organic fertilizer doses and shoot pruning in all observation parameters. The dose of organic fertilizer produced a significant effect on the number of fruit per plant and fruit weight per plant, while the shoot pruning treatment produced a significant effect on the fruit weight per plant and diameter of the cucumber fruit. Treatment with organic fertilizer dose of 45 kg/ha and shoot pruning the 15th segment of main stem gave the highest yield.

Keywords: Quantity, Quality, Organic fertilizer dose, Shoot pruning.

INTRODUCTION

Cucumber plants have a big opportunity to be further developed. Cucumber cultivation is not as widespread as other horticultural crops, such as chilies, tomatoes and green vegetables. However, demand for cucumbers increases every year due to increasing population. The average consumption of cucumbers also increases every year, it was recorded that in 2018 the average consumption of cucumbers for the Indonesian population was 2.06 kg/cap/year until in 2020 it was 2.19 kg/cap/year (Food Security Agency, Ministry of Agriculture, 2021). The increasing average consumption of cucumbers must be accompanied by the availability of productivity to fulfill public demand so that it is necessary to increase the productivity of cucumber plants both in quantity and quality. The quantity and quality of crop production can be increased through the provision of optimal fertilizer and the application of appropriate cultivation techniques (Dinca *et al.*, 2022). Most farmers prefer to use chemical fertilizer rather than organic fertilizer to increase production yields. However, there are concerns about the negative impact of chemical fertilizers on the environment. Chemical fertilizers can increase greenhouse gas emissions, pollute soil and water ecosystems (Chai *et al.*, 2019). Applying chemical nitrogen fertilizer is usually only absorbed by plants 50-60% (Scherer, 2005), then the rest will flow into rivers or groundwater (Craswell, 2021). Therefore, an alternative solution is needed by using fertilizer with controlled release (Lawrencia *et al.*, 2021). The use of organic fertilizer is economically feasible as one of the stages towards sustainable agriculture (Hui *et al.*, 2017). The combination of chemical fertilizer and organic fertilizer can increase soil fertility and affect plant productivity.

It can also increase fertilizer use efficiency (FUE) which has an impact on farmers' profits, especially soil in Indonesia which has lost a lot of nutrients (Goenadi *et al.*, 2018). One of the organic fertilizer products to increase plant productivity is Supernasa organic fertilizer. This fertilizer has several benefits that can help increase production and improve soil quality and is practical to use. Another effort to support increased productivity of cucumber plant can be done by shoot pruning. Cucumber plant will continue to grow upwards if the shoot is not pruned. This means that the distribution of nutrients can't be focused on generative growth in plant (Sofyadi *et al.*, 2021). Pruning cucumber plant is done to maintain a balance between vegetative growth and fruit growth so that maximum production can be achieved (Humphries and Vermilion, 1994). Pruning can reduce unproductive plant parts, so that the results of photosynthesis can be diverted to cell enlargement and affect fruit production (Yu *et al.*, 2013). The combination of organic fertilizer doses and shoot pruning are expected to support increased productivity of cucumber plants. The right dose of organic fertilizer will help fulfill nutritional requirements for cucumber plants and make efficient use of chemical fertilizers, then the nutrients absorbed can be focused on generative growth through shoot pruning. Therefore, this research can provide information about the effect of organic fertilizer doses and shoot pruning on the quantity and quality of cucumber plants.

MATERIALS AND METHODS**Time and Place of Research**

The research was conducted in April - July 2023 at Damarwulan Village, Kepung District, Kediri Regency, East Java, Indonesia.

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Materials and Tools

The materials for this research include hybrid cucumber seeds of the Mira variety, Supernasa organic fertilizer, urea fertilizer, NPK Phonska fertilizer, KCl fertilizer, insecticides and fungicides. The tools in the research were hoe, scissor, shovel, spray tank, ruler, caliper, analytical scale.

Research Methods

This research used a Split Plot Design (SPD) which had 2 factors, the dose of Supernasa organic fertilizer as a sub-plot and shoot pruning as the main plot. The dose of Supernasa organic fertilizer treatment consisted of 4 levels, 30 kg/ha (D1), 35 kg/ha (D2), 40 kg/ha (D3) and 45 kg/ha (D4). Meanwhile, the shoot pruning treatment consisted of 3 levels, without shoot pruning (P0), shoot pruning the 15th segment of main stem (P1), and shoot pruning the 20th segment of main stem (P2). The combination of the two treatments produced 12 combinations and was repeated 3 times for each treatment combination, so there were 36 experimental units. There were 10 plants in each experimental plot with 3 plants used as samples.

Observation Parameters and Data Analysis Models

The observation parameters in this research included the number of fruit per plant, fruit weight per plant, fruit length, fruit diameter, and fruit grade. Research data was collected and analyzed using Anova in Microsoft Excel. If the calculated F result is greater than the F table of 5%, the treatment have a real difference and continued Tukey Test 5%.

Research Implementation

The research started from cultivated the land and made beds and then made plant holes at a distance of 40 x 60 cm in a double row system. Supernasa organic fertilizer was given 5 days before planted by dissolved the appropriate dose per plant in 150 ml of water then poured it into the plant hole. Shoot pruning was carried out on the 15th and 20th segments of the main stem. Pruning was done by cut the shoot of main stem when the plant has 15 segment for treatment P1 and when the plant has 20 segment for treatment P2. Maintenance of cucumber plants during the research included replanted, installed stakes, installed vines, watered, tied cucumber stems, and controlled plant pest organisms. Cucumbers were harvested for 5 weeks at intervals of twice a week. The fruit harvested is perfectly ripe fruit with an overall uniform color.

RESULTS AND DISCUSSION

Number of fruits per plant

There was no interaction between the combination of organic fertilizer dose and shoot pruning on the parameter number of fruit per cucumber plant according to Anova analysis. However, the application of organic fertilizer at several dose levels produced a real effect, while shoot pruning treatment did not produce real results as presented in Table 1. The treatment of organic fertilizer dose 45 kg/ha produced the highest average number of fruit per plant (11.02 fruit) and produced a significant difference between treatments with an organic fertilizer dose 30 kg/ha (8.71 fruit) and an organic fertilizer dose of 35 kg/ha (10.19 pieces), but the dose 45 kg/ha did not

produce a significant difference with the organic fertilizer dose 40 kg/ha (10.51 pieces). Table 1. also shows that the highest average number of fruits per cucumber plant was found in the 15th segment of pruning treatment, amounting to 10.55 fruits, although it was not significantly different from other treatment levels.

Table 1. Average number of fruits per cucumber plant due to the effect of organic fertilizer dose and shoot pruning

Treatment	Number of Fruits Per Plant
Organic Fertilizer Dose	
D1 (30 kg/ha)	8.71 a
D2 (35 kg/ha)	10.19 b
D3 (40 kg/ha)	10.51 bc
D4 (45 kg/ha)	11.02 c
Tukey Test 5%	0.85
Shoot Pruning	
P0 (Without Shoot Pruning)	9.65
P1 (15 th segment of main stem)	10.55
P2 (20 th segment of main stem)	10.11
Tukey Test 5%	ns

*Numbers followed by the same letter in the same column and treatment show no significant difference based on Tukey Test 5%; ns = not significant.

The result of the quadratic regression analysis between organic fertilizer dose and the number of fruit per plant (Figure 1) produced the line equation $Y = -0.0097x^2 + 0.8725x - 8.6675$ ($R^2 = 0.9692$). Based on this equation, the highest dose of organic fertilizer ($Y^1 = 0$) which influenced the highest increase in the number of cucumbers was 44.97 kg/ha. Therefore, if the dose of organic fertilizer is increased again, it will actually result in a decrease in the number of fruits formed.

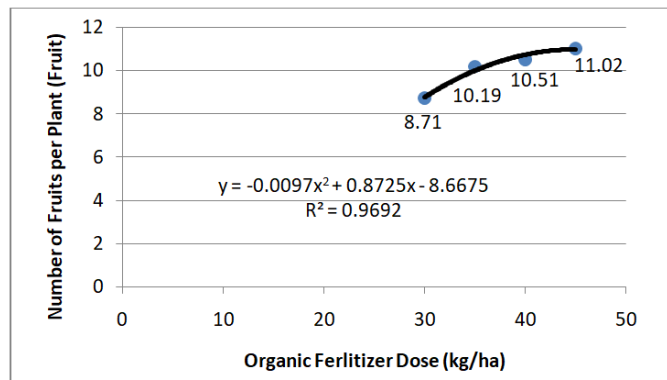


Figure 1. Quadratic Regression Graph of the Relationship Between Organic Fertilizer Dosage and Number of Fruits per Cucumber Plant

Fruit weight per plant

There was no interaction between the combination of organic fertilizer dose and shoot pruning on the fruit weight per cucumber plant based on Anova analysis. However, treatment with organic fertilizer dose and shoot pruning both produced significant effects as presented in Table 2. The treatment of organic fertilizer dose 45 kg/ha produced an average fruit weight per cucumber plant of 3.45 kg (the heaviest) and had a significant difference with the treatment of organic fertilizer doses 30 kg/ha and 35 kg/ha, but the treatment of organic fertilizer dose 45 kg/ha did not produce a significant difference with the treatment of organic fertilizer dose 40 kg/ha. There was a tendency to increase fruit weight per cucumber plant due to the additional dose of organic fertilizer given. Pruning the 15th segment of main stem produced a fruit weight per plant of

3.23 kg (the heaviest) and produced a significant difference with the main stem which was not pruned but did not produce a significant difference with shoot pruning the 20th segment of main stem. There was a tendency to increase fruit weight per cucumber plant due to the influence of shoot pruning.

Table 2. Average fruit weight per cucumber plant due to the effect of organic fertilizer dose and shoot pruning

Treatment	Fruit Weight Per Plant (kg)
Organic Fertilizer Dose	
D1 (30 kg/ha)	2.51 a
D2 (35 kg/ha)	2.94 b
D3 (40 kg/ha)	3.19bc
D4 (45 kg/ha)	3.45 c
Tukey Test 5%	0.37
Shoot Pruning	
P0 (Without Shoot Pruning)	2.79 a
P1 (15 th segment of main stem)	3.22 b
P2 (20 th segment of main stem)	3.06 ab
Tukey Test 5%	0.40

*Numbers followed by the same letter in the same column and treatment show no significant difference based on Tukey Test 5%.

Fruit Length

There was no interaction between the combination of organic fertilizer dose and shoot pruning on the average length of cucumber fruit based on Anova analysis. Likewise, the single factors of organic fertilizer dose and shoot pruning also did not produce a significant effect on the average length of cucumber fruit as presented in Table 3.

Table 3. Average fruit length due to the effect of organic fertilizer dose and shoot pruning

Treatment	Fruit Length (cm)
Organic Fertilizer Dose	
D1 (30 kg/ha)	22.00
D2 (35 kg/ha)	22.17
D3 (40 kg/ha)	22.19
D4 (45 kg/ha)	22.54
Tukey Test 5%	ns
Shoot Pruning	
P0 (Without Shoot Pruning)	21.88
P1 (15 th segment of main stem)	22.68
P2 (20 th segment of main stem)	22.12
Tukey Test 5%	ns

*ns = not significant

The treatment of organic fertilizer dose and shoot pruning did not produce a significant effect on the average length of cucumber fruit. However, there was a tendency to increase the average length of cucumber fruit due to increasing the dose of organic fertilizer up to 45 kg/ha.

Table 5. Fruit grade due to treatment with organic fertilizer dose and shoot pruning

Organic Fertilizer Dose	Shoot Pruning	Grade A (%)	Grade B (%)	Grade C (%)
30 kg/ha	Without pruning	16.37%	40.00%	43.63%
30 kg/ha	15 th segment	13.12%	45.90%	40.98%
30 kg/ha	20 th segment	18.47%	38.46%	43.07%
35 kg/ha	Without pruning	16.95%	38.99%	44.06%
35 kg/ha	15 th segment	16.13%	46.77%	37.09%
35 kg/ha	20 th segment	14.66%	46.67%	38.67%
40 kg/ha	Without pruning	17.65%	44.12%	38.23%
40 kg/ha	15 th segment	21.25%	46.25%	32.50%
40 kg/ha	20 th segment	19.23%	44.87%	35.89%
45 kg/ha	Without pruning	19.49%	44.15%	36.36%
45 kg/ha	15 th segment	21.95%	46.34%	31.71%
45 kg/ha	20 th segment	21.25%	42.50%	36.25%

Grade A: Fruit length >26 cm, straight fruit with an even diameter and smooth skin

Grade B: Fruit length 22 – 26 cm, straight fruit with an even diameter and smooth fruit skin

Grade C: Fruit length <22 cm or fruit is crooked and has an uneven diameter

An organic fertilizer dose 45 kg/ha was able to produce the highest average length of cucumber fruit compared to other treatments. There was also a tendency to increase the average length of cucumber fruit due to pruning treatment compared to without pruning as presented in Table 3.

Fruit Diameter

There was no interaction between the treatment combination of organic fertilizer dose and shoot pruning on the average diameter of cucumber fruit based on the result of Anova calculation. However, the single factor of shoot pruning produced a significant difference on the average diameter of cucumber fruit, while the organic fertilizer dose treatment did not produce a significant difference as presented in Table 4.

Table 4. Average fruit diameter due to the effect of organic fertilizer dose and shoot pruning

Treatment	Fruit Diameter (cm)
Organic Fertilizer Dose	
D1 (30 kg/ha)	4.85
D2 (35 kg/ha)	4.89
D3 (40 kg/ha)	4.90
D4 (45 kg/ha)	4.92
Tukey Test 5%	ns
Shoot Pruning	
P0 (Without Shoot Pruning)	4.82 a
P1 (15 th segment of main stem)	4.98 b
P2 (20 th segment of main stem)	4.88 ab
Tukey Test 5%	0.11

*Numbers followed by the same letter in the same column and treatment show no significant difference based on Tukey Test 5%; ns = not significant.

Providing organic fertilizer in several dose levels did not produce a significant difference, but there was a tendency to increase the average diameter of cucumber fruit due to the additional dose of organic fertilizer given. Pruning produced a significant difference on the average parameter of cucumber fruit diameter. Pruning the 15th segment of main stem produced the highest fruit diameter and resulted in a significant difference from the treatment of plants that were not pruned, but the treatment of pruning 15th segment of main stem not produce a significant difference from the treatment of pruning 20th segment of main stem.

Fruit Grade

The cucumber fruit produced as a result of treatment with organic fertilizer doses and shoot pruning had different grades. Grade A is the best grade with the criteria for a cucumber fruit length more than 26 cm with straight fruit, even diameter and smooth fruit skin.

Grade A was highest in the treatment combination of 45 kg/ha organic fertilizer dose and shoot pruning the 15th segment of main stem, namely 21.95% of the total number of fruit in this treatment combination. Grade B is a medium grade with the criteria for a fruit length of 22 – 26 cm with straight fruit, even diameter and smooth fruit skin. Grade B was mostly found in the treatment combination of 35 kg/ha organic fertilizer dose and shoot pruning the 15th segment of main stem as much as 46.77% of the total number of fruit in this treatment combination. Grade C is the lowest grade with the criteria for a fruit length of less than 22 cm or a crooked fruit shape with an uneven fruit diameter. Grade C was highest in the treatment combination of 35 kg/ha organic fertilizer dose and without shoot pruning, namely 44.06% of the total number of fruit produced in this treatment combination.

DISCUSSION

Effect of organic fertilizer dose on the quantity and quality of the product of cucumber

The treatment of organic fertilizer dose 45 kg/ha produces the highest quantity and quality of cucumber plants compared to other fertilizer dose treatments. Based on this, a dose of organic fertilizer 45 kg/ha can substitute for the fulfillment of nutrients in plants so that plant production results are maximum. According to Liu *et al.* (2009) reducing chemical fertilizer and adding organic fertilizer can increase microbial biomass in the soil and the availability of nutrients needed by plants compared to using only chemical fertilizer. In line with research by Pan *et al.* (2009) a combination of chemical fertilizer and organic fertilizer can increase the efficiency of nitrogen elements and rice yields due to the accumulation of organic carbon. Research conducted by Zhang *et al.* (2009) also showed that a combination of chemical fertilizer and straw or cow dung fertilizer can increase plant productivity, maintain soil fertility and soil buffer capacity. The combination of chemical fertilizer and organic fertilizer can increase the efficiency of using chemical fertilizer. Marpaung (2014) explained that increasing the dose of fertilizer given to plants will result in an increase in the amount of nutrients received by the plants and increase the yield components. Increasing crop production can be influenced by the adequacy of various nutrients available in the soil Sari *et al.*, (2023). Waskito *et al.* (2017) explained that plant production results will not be optimal if the fertilizer dose is insufficient for the plants. More photosynthesis results are produced if the dose of fertilizer given is sufficient so that the results of photosynthesis can be stored in the fruit. This will cause the length and diameter of the fruit to increase.

Effect of shoot pruning on the quantity and quality of the product of cucumber

The treatment of pruning 15th segment of main stem resulted in the best average quantity and quality of cucumber plant production compared to other pruning treatments. Gustia (2016) explained that shoot pruning can stimulate the formation of female flowers and fruit due to the accumulation of assimilate. Research conducted by Preece and Read (2005) showed that pruning can limit the vegetative growth of tomato plants and allow more sunlight to enter and increase the quantity and quality of tomato plants. In accordance with the opinion of Sofyadi *et al.* (2021) that shoot pruning is intended to reduce competition for the use of photosynthesis results

between vegetative organs and generative organs. The continuation of vegetative growth can be inhibited by shoot pruning, so that the results of plant photosynthesis can be focused more on the generative organs. Pruning the 15th segment of main stem was done when the plant had entered the generative period because flowers had formed (Zamzami *et al.*, 2015). Sumajow *et al.* (2016) explained that pruning carried out in the generative phase will allow nutrients to be focused more on forming generative organs (flowers and fruit) so it can maximize production results. Poerwanto and Anas (2014) explained that pruning can balance the distribution of fruit produced by the plant so that the size and quality of the fruit produced can be uniform and encourage the regular formation of flowers and fruit.

Conclusion

There was no interaction between the combination of organic fertilizer doses and shoot pruning on the quantity and quality of production results in all observation parameters. The Treatment with 45 kg/ha organic fertilizer dose produced the highest quantity and quality of yield compared to other doses. The shoot pruning treatment 15th segment of main stem produced the highest quantity and quality of yield in general compared to other pruning treatments. The highest percentage of grade A fruit was found in the combined treatment with 45 kg/ha organic fertilizer dose and pruning the 15th segment of main stem.

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