Effects of pruning on growth and yield of cucumber (\textit{Cucumis sativus}) Mercy variety in The acid soil of North Kalimantan, Indonesia

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Abstract. Mardhiana, Pradana AP, Adiwena M, Kartina, Santoso D, Wijaya R, Maliki A. 2017. Effects of pruning on growth and yield of cucumber (\textit{Cucumis sativus}) Mercy variety in The acid soil of North Kalimantan, Indonesia. Cell Biol Dev 1: 13-17. In recent years, cucumber production in Tarakan, North Kalimantan only reaches 20 tons ha$^{-1}$. In fact, cucumber production potential could reach 49 tons ha$^{-1}$. Several factors that limit the low productivity of cucumbers in Tarakan are acid soil and cultivation techniques which are still limited. This study aimed to determine the effect of pruning on the growth and yield of cucumbers in acid soil in Tarakan. The study was conducted using Randomized Complete Block Design with the treatment of without pruning (P0), shoot of prunings on the main stem (P1), pruning of whole lateral branches above the third section (P2), and pruning of 2 lateral branches that emerged first above the third section (P4). The results showed that plant height was 16.17% (P1) and 2.26% (P2) lower also 0.13% higher (P3) than the control (P0). The highest number of leaves was found in treatment P1 (16.19%) compared to P0. The best fruit diameter was also found in P1 treatment with 4.93% difference compared to P0. Furthermore, a highly significant and the best result on weight per fruit were also obtained by P1 treatment. The results showed that the fruit weight of P1 treatment (11.39%) was higher than P0. This study provided new information that the pruning treatment of shoots on the main stem of cucumber variety Mercy in acid soil could increase the diameter and weight of cucumber.

Keywords: Fruit diameter, lateral branches, leaves, low pH, main stem

INTRODUCTION

Cucumber (\textit{Cucumis sativus} L.) is one of the vegetable crops from Cucurbitaceae family commonly planted by farmers in Indonesia. Cucumber cultivation is widespread throughout the world, both tropical and sub-tropical area. Cucumber plants in Indonesia are grown in lowlands to highlands. The central regions of cucumber cultivation area in Indonesia are West Java, East Java, Central Java, Aceh, and Bengkulu. DNA sequencing found that melon and cucumber are Asian origin and have numerous previously overlooked species-level relatives in Australia and around the Indian Ocean (Sebastian et al. 2010).

Cucumber production in Indonesia is still relatively low. Based on data from the Central Bureau of Statistics, cucumber production in Indonesia continues to decline from year to year. In 2011 to 2015, the cucumber productions were 521,535 tons, 511,525 tons, 491,636 tons, 477,989 tons and 447,696 tons respectively. Besides genetic factors, environmental factors such as climate, cultural practices, and post-harvest condition affect on plant performance (Crawley 2009). The proper cultivation techniques as one of cultural practice need to do in Indonesia to increase the cucumber production.

Increasing cucumber production requires appropriate cultivation techniques. One possible action taken to increase the cucumber production is by improving the cultivation techniques through a proper pruning. According to Usenik et al. (2008), pruning influenced vegetative growth, fruit quality and had no negative effect on peach. Cucumber plants of age about 21 Days After Planting (DAP) usually grow with very dense branch and leaves which lead to producing a vegetative growth only, so the formed flowers and fruits tend to decrease.

Some cucumber farmers in Tarakan City have not done the intensive cultivation techniques such as pruning. Whereas, pruning can affect plants. According to Beadle et al. (2007), pruning in \textit{Acacia} trees can decrease the total number of branches and improved stem straightness. With few branches, the plant will get an optimized light availability. Light gives an effect to plant developmental processes (Feng et al. 2008). The application of pruning technique is still a few due to the limited knowledge and poor information obtained by farmers.

Cucumber cultivation needs to be developed appropriately and sustainably. Pruning is needed as the effort to increase the growth and yield of cucumbers. Therefore, the pruning treatment experiment is expected to increase the growth and yield of cucumber. This study aimed to determine the effect of pruning on the growth and yield of cucumber variety Mercy in acid soils in Tarakan, North Kalimantan, Indonesia.
MATERIALS AND METHODS

Time and site of study
The study was conducted in Experimental Farm of Faculty of Agriculture, Universitas Borneo Tarakan, Tarakan, North Kalimantan, Indonesia from December 2016 to February 2017.

Experimental design
The study was conducted using Randomized Complete Block Design with the treatment of without pruning (P0), shoot of prunings on the main stem (P1), pruning of whole lateral branches above the third section (P2) and pruning of two lateral branches that emerged first above the third section (P3). These treatments replicated five times so that there are 20 units of experimental unit. Each experimental unit consists of four plant samples, so the total sample is 80.

Cultural practice
The study area was measured and cleared from weeds and other plants grown. The land was dug with a depth of ± 20 cm by using a hoe. Planting process was done using a dough tool with a depth of 3-5 cm at the distance of 60 cm between the rows and 30 cm within the rows. Two seeds are inserted into the planting hole, then covered with a little of soil. A routine watering was done every day in the morning especially in the early phase of growth at the age of 7-14 DAP. Watering was done every two days when the cucumber flowers were emerged and were not done when it rains. Stitching was done when the plant is at the age of 14 DAP by replacing the plant that died or grows abnormally with new plants and thinning was done by leaving one best plant per planting hole at the plant age of 21 DAP. Application of stake was done when cucumber plant at the age of a week after planting. This study used bamboo or wood as a stoke marker of each plant and connected each other with ropes.

Basic fertilization used manure with fertilizer dose of 20 tons ha⁻¹ (429 g plant⁻¹). Further fertilization was done at the planting time and when the plants at the age of 10 days after planting. The fertilizers applied were urea 280 kg ha⁻¹ (6 g plant⁻¹), SP-36 260 kg ha⁻¹ (5 g plant⁻¹) and KCl 525 kg ha⁻¹ (9.5 g plant⁻¹). The half dose was applied at the planting time and when the plants at the age of 10 DAP. Fertilizer was inserted into the soil with a distance of ± 15 cm from the stem. The cucumber fruits that were ready to be harvested followed the criteria: the fruit was green and diameter was more than 2.5 cm. Cucumbers were harvested until the productive harvest was complete. Harvesting was done at the age of 47, 48, and 49 DAP.

Pruning
Pruning of maintenance was done by removing leaves and branches that grow before the third section. Treatment of cucumber pruning was done in accordance with the applied treatment. Pruning was done when the plant was 33 DAP using a pruning shears to obtain a good pruning results.

Data analysis
Data of observation result were analyzed by using Variance Analysis (F test) to know the effect of treatment given. If the significant different result found the Least Significance Different (LSD) test with 95% confidence level then conducted.

RESULTS AND DISCUSSION

Based on the analysis of variance, there is an effect of pruning in cucumber. Pruning highly affected the plant length, number of leaves, fruit diameter and fruit weight and affect on flowering age. However, the pruning did not affect the fruit length and the number of fruits per plant. The recapitulation of the effects of pruning on the growth and yield of cucumber is described in Table 1.

Based on the result of the variance, it is known that the pruning treatment has a very significant effect on the cucumber length of at the age of 50 DAP (Figure 1). Figure 1 showed the treatment of pruning of two lateral branches that emerged first above the third section (P3) showed the highest yield compared to other treatments of 272.45 cm, but not significantly different with the treatment of P0 and P2. Treatment of shoot pruning on the main stem (P1) significantly resulted in the shorter plant than other treatments with no shoot pruning, but visually it was seen that the branch was longer than that of without pruning.

Treatment of shoot pruning on the main stem (P1) resulted in the highest number of leaves per plant (59.90 pieces of leaves) compared to other treatments. Treatment of shoot pruning on the main stem could increase the number of leaves by 16.19% compared to that of without pruning (P0). The number of cucumber leaves due to the effect of pruning in detail is shown in Figure 2.

Based on the 5% LSD test, it is known that the shoot pruning treatment on the main stem (P1) and the pruning of the two lateral branches that emerged first above the third section (P3) yielded the fastest flowering time rate compared to other treatments, which is 38 DAP. In general, pruning treatments (P1, P2, and P3) can accelerate the flowering times rather than without pruning treatment (P0). P1 and P3 could shorten the flowering time of 2.93% compared to without pruning treatment (P0). The average flowering age of cucumber due to pruning in detail is shown in Figure 3.

The result of variance analysis showed that all cucumber pruning treatment had no significant effect on fruit length and number of fruit per plant (Table 2). Based on the results, the average fruit length was 19.98 cm, and the average number of fruit that is harvestable in each sample was 3.11 pieces. The data in a number of fruit parameter is the data for harvestable fruit. All of the treatments were suspected to be incapable of producing optimal assimilates so that they were insufficient to increase the number of harvestable fruit.
Table 1. Recapitulation of the results of the effects of pruning on the growth and yield of cucumbers

<table>
<thead>
<tr>
<th>Parameters</th>
<th>F test result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant length</td>
<td>**</td>
</tr>
<tr>
<td>Number of leaves</td>
<td>**</td>
</tr>
<tr>
<td>Flowering age</td>
<td>*</td>
</tr>
<tr>
<td>Fruit length</td>
<td>ns</td>
</tr>
<tr>
<td>Fruit diameter</td>
<td>ns</td>
</tr>
<tr>
<td>Number of fruit per plant</td>
<td>**</td>
</tr>
<tr>
<td>Fruit weight</td>
<td>**</td>
</tr>
</tbody>
</table>

Note: ns = not significantly different; *= significantly different
**= highly significantly different

Table 2. Effect of pruning on fruit length and number of fruit per plant

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fruit length (cm)</th>
<th>Number of fruit per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>P0</td>
<td>19.68 ns</td>
<td>3.15 ns</td>
</tr>
<tr>
<td>P1</td>
<td>20.05 ns</td>
<td>3.00 ns</td>
</tr>
<tr>
<td>P2</td>
<td>20.20 ns</td>
<td>3.20 ns</td>
</tr>
<tr>
<td>P3</td>
<td>19.99 ns</td>
<td>3.10 ns</td>
</tr>
<tr>
<td>Average</td>
<td>19.98</td>
<td>3.11</td>
</tr>
</tbody>
</table>

Note: ns= not significantly different; P0: treatment of without pruning (P0), shoot of prunings on the main stem (P1), pruning of whole lateral branches above the third section (P2), and pruning of 2 lateral branches that emerged first above the third section (P3).

The result of the statistical test showed that the pruning treatment had a significant effect on fruit diameter. The general pruning treatment (P1, P2, and P3) was able to increase the fruit diameter compared to the treatment without pruning (P0). The effect of pruning on average fruit diameter in detail is shown in Figure 4.

The highest average fruit diameter was obtained by the pruning treatment of shoot on the main stem (P1) of 4.26 cm. The shoot of prunings on the main stem was able to increase the percentage of fruit diameter by 4.92% compared to the treatment without pruning. The addition of fruit diameter is closely related to the number of leaves. The optimal leaf surface area can produce assimilate which is able to increase the fruit diameter.

The result of the statistical test showed that the pruning treatment had a significant effect on the production per plant. Treatment of shoot pruning on the main stem (P1) yielded the highest average weight per fruit of 427.11 g plant\(^{-1}\) compared to other treatments (P0, P2, and P3). The effect of pruning on weight per fruit is shown in Figure 5.

In general, pruning treatments (P1, P2, and P3) had a better effect on average weight per fruit than that of without pruning (P0). The best result was obtained by P1 treatment which showed an increase of 11.38% compared to without pruning treatment (P0).
Discussion

The plants are pruned on the main stem are shorter than other treatments. It might be related to the flow of auxin in the plants, the synthesis of auxin on the shoot of the main stem is stopped due to the shoot pruning, while the synthesis of cytokinin increased and further affect the growth of branch growth. Ghosh et al. (2011) said that pruning suppresses apical dominance. The apical meristem and the young leaves are the centers of TAA and IAA (Indole Acetic Acid) synthesis which are then transported to the stems thus inhibiting the development of lateral shoots. IAA is one type of auxin that causes apical dominance. IAA is a trigger for change in plant development (Vanneste and Friml 2009).

The cucumber length was not positively correlated with the yield. This was proofed by the production data. The plant stems are not a major contributor to photosynthesis, but it is more affected by the number of leaves. The optimal number of leaves is the largest contributor to photosynthesis result because the leaf is a plant organ who have stomata associated with photosynthesis (Xu and Zhou 2008). Fischer et al. (2012) said that increasing the leaf-fruits ratio generally increases fruit growth and carbohydrates content.

Basically pruning is intended to control the optimal number of leaves thereby improving the yield. Pruning is an attempt to create a better state of the plant, so that sunlight can enter to the whole parts of the plant, increase interception of light into the canopy of plants and increase the availability of air circulation and CO₂ in the canopy. The sufficient light and CO₂ and other supporting factors will increase the photosynthesis rate which leads to increase the availability of photosynthesis. The excessive vegetative growth caused a suboptimal use of photosynthesis results and led to decrease the yield production (Coggins Jr and Lovatt. 2014).

The shoots of pruning on the main stem might be able to inhibit the production of auxin in the main stem and increase cytokinin hormone. This affects the extension of the lateral branches, the longer lateral branches produce a larger number of section, as the increasing number of the section will also increase the number of leaves. Meier and Leuschner (2008) said that leaf expansion and stand leaf area of beech are controlled by several abiotic factors including spring temperature and possibly also nitrogen supply. Nitrogen affects photosynthesis and photoprotection in leaves (Pompelli et al. 2010) and the results of these photosynthates which will be used by plants to support an increase in yields (Hibberd et al. 2010).

The production of auxin in the main stem continues to proceed without the shoot of prunings. This is certainly not expected by farmers because it will make an apical dominance that results in a longer vegetative phase and inhibition of flowering time of the plant. This was in line with Dun et al. (2009) statement that the production of auxin might trigger the production of a second hormone to inhibit bud outgrowth.

The shoot of pruning on the main stem (P1) is expected to create an optimal growing space for the leaves which perform photosynthesis. The result of the photosynthesis allocated for cell enlargement in the fruit tissue since the meristematic cells in the fruit will result in increasing the volume size so that the cell growth is in line with the increase of fruit diameter. Pruning essentially reduces unproductive parts of the plant so that the assimilate of the photosynthesis process is more widely allocated to enhance other plant growth processes such as cell enlargement. Photosynthesize as a photosynthesis result has a positive effect on fruit (Yu et al. 2013).

Cucumber pruning is able to produce a better fruit weight. It is proven by the fruit weight that is produced by shoot of pruning on the main stem (P1) which is able to gain a weigher fruit in the cucumber Mercy variety is between 350-400 g per fruit. Although the average fruit weight shows an improvement, it has not been able to achieve the average yield of cucumber Mercy variety. Based on the data, cucumber Mercy variety is able to produce 3.5-5 kg plant⁻¹, while the study conducted only reached 1.28 kg. This might be caused by the cucumber harvested only 3 times because after the 3rd harvest time the plant suffered a pest attack of fruit fly (Bactrocera sp.) causing rotten cucumber fruit and not feasible to harvest. This study provided a new information that shoot of prunings on the main stem could increase the quantity (fruit weight) of cucumber Mercy variety in acid soils in Tarakan, North Kalimantan.

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