The influence of pinching on the growth, flowering pattern and yield of butternuts (*Cucurbita moschata*)

Beura Eve¹, Mtaita Tuarira¹, Mutetwa Moses² and Masaka Thomas¹

¹Department of Horticulture, Faculty of Agriculture and Natural Resources, Africa University, Box 1320, Old Mutare, Zimbabwe
²Alumni, Department of Horticulture, Faculty of Agriculture and Natural Resources, Africa University, Box 1320, Old Mutare, Zimbabwe

A field experiment was conducted at Africa University farm, Mutare, Zimbabwe to evaluate the effects of pinching on the growth, flowering pattern and yield of butternuts (*Cucurbita moschata*). The experiment was laid as a Randomized Complete Block Design. *Cucurbita moschata* was used as the test crop with evaluation being the yield, flowering pattern, branches, stems and fruit weight. Treatment groups included no pinching, pinching at 2⁰ node, pinching at 4⁰ node and pinching at 6⁰ node. Treatments with pinching had the highest yield (18.80 t/ha) and highest number of flowers (5.10) compared to plants with no pinching. Pinching plants at 6⁰ node increased the number of branches compared to pinching plants at 2⁰ node. The number of stems were highest (3.65) in pinched plants (TRT 4) compared to plants which did not receive pinching. General trends showed that number of stems increased as pinching was done at a later stage. The number of fruits harvested in plants per treatment corresponded to the fruit weight gained. The greater the number of harvested fruits, the higher the corresponding weight and vice versa. These findings indicated that pinching plants at a later stage of its growth promotes the growth, flowering pattern and yield of plants.

**Keywords:** Butternuts, pinching, nodes, flowering pattern, fruit yield.

**INTRODUCTION**

Butternut (*Cucurbita moschata*) plays an important role in human nutrition, providing vitamins and other micronutrients. It is widely grown for its fruits, but its leaves are also important as a vegetable for some communities (Loy, 2004). Butternuts a commercial crop where pinching is done to promote branching and flowering. Pinching is the manual removal of the growing tips of plants and the first set of leaves as a way to control plant size, to promote bushiness, and to increase density. The practice is commonly undertaken to promote bushy growth of the canopy by counteracting the effects of apical dominance (Mathew and Karikari, 1995). Judicial pinching or pruning increases the supply of nitrogen and other essential elements and in turn increases the production of carbohydrates for the reproductive phase. Removal of apical dominance enhances the growth of lateral branches. At the end of a branch of the plant, is the terminal bud where all growth develops and in that tip is a hormone that suppresses the growth of the side buds. When the terminal bud and its hormone is removed by pinching, the side buds are permitted to grow and flourish leading to more compact plants and higher yields of flowers.

*Corresponding author:* Mutetwa Moses Department of Horticulture, Faculty of Agriculture and Natural Resources, Africa University, Box 1320, Old Mutare, Zimbabwe. Email: tmaita@aficau.edu, mosleymute@gmail.com
Experiments conducted by Hikosaka and Sigiyama (2004) in a greenhouse showed that pinching of terminal buds of cucumbers helped to increase female flower production and hence more fruits. Pinching just above the first set of Basil (*Ocimum basilicum*) leaves encouraged nodes under the little leaves to grow more side branches and removed apical dominance (Central Coast Gardening, 2010). Iannotti (2009) indicated that, pinching prevents apical dominance and invigorates the growth of the lower parts of tomato plants. In a study by Arin and Ankara (2001), pinching of tomatoes promoted plant growth, earliness, total yield and quality fruit production. Pinching chili at early growth stages increased the marketable yield to total yield ratio, fruit number, and the production of physiologically ripe fruits (Buczkowska, 2001). However, Smakel (2006) cautioned that there should be enough justification for the removal of a portion of a plant through long term observations and experience since such removal can be either injurious or beneficial. In Zimbabwe butternuts are increasingly being used locally in place of pumpkins and are also becoming more important in processing and prepared foods. However there is little adoption of pinching techniques on butternuts by most farmers. This is partly because little research have been done and published on pinching of butternuts plants. Consequently, there is need to investigate the effect of pinching in relation to the growth, flowering pattern and fruit yield of butternuts. The main objective of this research was therefore to assess the effects of nodal pinching on growth, flowering pattern and yield of butternuts.

**MATERIALS AND METHODS**

**Experimental site, design and Crop establishment**

The experiment was conducted at Africa University Farm (AU) in Mutare, Zimbabwe; located at 18°53’S, 32°35’E and 1104m altitude. The experiment was laid out in a randomized complete block design (RCBD). Seeds from Starke Ayres of the variety GILDA. There were a total of four replications (Plate 1) each with four plots. Pinching of terminal bud was the main factor under investigation. Treatments were as follows:

- **TRT 1**: No pinching (control)
- **TRT 2**: Pinching at 2nd node above soil level
- **TRT 3**: Pinching at 4th node above soil level
- **TRT 4**: Pinching at 6th node above soil level

The land was ploughed and harrowed on November 1st 2015 during the wet season. It was measured to cover a land size of 20m x 20m for the experiment. Lining and pegging to divide the area into four blocks and 16 plots were carried out. The intra and inter row spacing between holes were 1m x 1m respectively. There were a total of 160 planting stations for the 4 replications. Three seeds were placed in each hole with 5g of basal fertilizer Compound D (7:14:7) incorporated into every hole. Regular watering, hand weeding and hoeing were done. Gradual thinning began when plants had attained 3 to 4 true leaves. At the end of two weeks after seeds germinated, seedlings were thinned to one plant per planting station. During the growing season pesticides (Karate, 10ml/10ltrs water; Malathion, 30g/10ltrs water) were applied when necessary.

**Parameters measured**

- **Number of leaves per plant**: This was recorded by counting the number of leaves from the base of the main stems to the tip of the top most leaf at 45 days after planting (DAP).
- **Number of main stems per plant**: Number of stems were counted and recorded from the base of the main stem to the tip of the plant where pinching was done at 45 DAP.
- **Number of main branches per plant**: This was recorded by counting the numbers of main branches from the main stem at 60 DAP.
- **Number of female flowers per plant**: Female flowers were identified (Plate 2), counted and recorded from the main stems.
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Table 1. Shows the mean number of leaves, stems, branches and female flowers per plant in butternuts as affected by pinching treatment

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Number of leaves</th>
<th>Number of stems</th>
<th>Number of branches</th>
<th>Number of female flowers</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT 1</td>
<td>23.33d</td>
<td>1.23a</td>
<td>2.33a</td>
<td>3.55a</td>
</tr>
<tr>
<td>TRT 2</td>
<td>18.45c</td>
<td>1.73b</td>
<td>3.35b</td>
<td>4.16b</td>
</tr>
<tr>
<td>TRT 3</td>
<td>16.85b</td>
<td>3.33c</td>
<td>4.18c</td>
<td>4.90c</td>
</tr>
<tr>
<td>TRT 4</td>
<td>13.23a</td>
<td>3.65c</td>
<td>4.48c</td>
<td>5.10c</td>
</tr>
<tr>
<td>Mean</td>
<td>17.97</td>
<td>2.48</td>
<td>3.58</td>
<td>4.43</td>
</tr>
</tbody>
</table>

Significance  
LSD_{0.05} 1.377 0.4845 0.4975 0.4468  
CV% 4.8 12.8 8.7 6.3

K,b*denotes significance at P<0.05.  
Figures not sharing a common letter in a column differed significantly at 0.05 probability.

Average fruits per hectare: This was recorded by counting the number of fruits on each plant during harvest time and converting to hectare basis.

Average fruits per plant: Total number of fruits were counted for every treatment and divided by the total number of plants in the treatment.

Average weight per fruit: An electronic weighing scale was used to weigh all harvested fruits per treatment and then divided by the number of fruits per treatment.

Fruit weight per plant: An electronic weighing scale was used to weigh all harvested fruits per plant.

Gross yield: This was recorded by weighing of fruits in each treatment and expressed per hectare basis.

 Marketable fruit: Marketable yields (uniform colour, size and shape, undamaged by pests and also disease free) were sorted out and counted per treatment and projected as percentage.

Statistical analysis

Data collected was statistically analyzed using the GenStat Analysis of Variance (ANOVA) software. Differences between means were determined using the Least Significant Difference (LSD) test at P=0.05 level.

RESULTS

Number of leaves: As indicated in Table 1, there were significant differences (P<0.05) for the pinching treatment with regard to number of leaves. Treatments TRT 4 and TRT 3 had significantly lower number of leaves (13.23 and 16.85 respectively) which were below the mean. Treatment TRT 1 had the highest number of leaves (23.33).

Number of stems: Influence of pinching on number of stems is shown in Table 1. Pinching treatments revealed significant differences (P<0.05) with TRT 1 having the lowest number of stems (1.23). Treatment 4 recorded the highest number (3.65) of stems. The results also show that TRT 3 and TRT 4 were not statistically different from each other. Mean number of stems was 2.48.

Number of branches: Number of branches showed significant (P<0.05) difference for the pinching treatments (Table 1). Treatment TRT 4 recorded the highest number of branches (4.48). TRT3 and TRT 4 were not significantly different from each other. Treatment TRT 1 recorded the least number of branches (2.33). Mean number of branches was 3.58.

Number of female flowers: Data pertaining to number of female flowers per plant revealed that there were significant (P<0.05) differences among the means for the treatments investigated (Table 2). Treatment TRT 1 recorded the lowest number of female flowers (3.55) while TRT 4 had the highest number of female flowers (5.10). Comparison of pinching to no pinching reveal that the pinching produced significantly higher numbers of flowers than no pinching. Mean for number of female flowers was 4.43.

Average fruit weight: The comparison of means as influenced by the pinching treatments is shown in Table 2. The influence of pinching was significant (P<0.05) on the average weight of fruits in this investigation. The highest weight (0.545 kg) was recorded from TRT 3 while the lowest weight (0.378 kg) was recorded from TRT 4. A comparison between pinching and no pinching
Table 2. Shows the means of average fruit weight, number of fruits per hectare and fruit weight/plant characteristics as affected by pinching

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Average Weight (kg)</th>
<th>Fruit Number of fruits per Ha</th>
<th>Fruit Weight per plant (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRT 1</td>
<td>0.4185&lt;sup&gt;b&lt;/sup&gt;</td>
<td>26 362&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.987&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>TRT 2</td>
<td>0.4885&lt;sup&gt;c&lt;/sup&gt;</td>
<td>32 468&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.429&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>TRT 3</td>
<td>0.5448&lt;sup&gt;d&lt;/sup&gt;</td>
<td>38 850&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1.614&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>TRT 4</td>
<td>0.3778&lt;sup&gt;a&lt;/sup&gt;</td>
<td>47 452&lt;sup&gt;d&lt;/sup&gt;</td>
<td>1.910&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Mean</td>
<td>0.4574</td>
<td>36 283</td>
<td>1.485</td>
</tr>
</tbody>
</table>

Significance
LSD<sub>0.05</sub> 0.03304 3 838.5 0.1708
CV% 4.5 6.6 7.2

*denotes significance at P<0.05.

Figures not sharing a common letter in a column differed significantly at 0.05 probability.

Key
TRT 1- No pinching
TRT 2- Pinching at 2 nodes
TRT 3- Pinching at 4 nodes
TRT 4- Pinching at 6 nodes

Figure 1. Shows the means of the effect of pinching on number of fruit yield.

![Graph of fruit yield](image)

Figures not sharing a common letter differed significantly at 0.05 probability.

Key
TRT 1- No pinching
TRT 2- Pinching at 2 nodes
TRT 3- Pinching at 4 nodes
TRT 4- Pinching at 6 nodes

The influence of pinching on the growth, flowering pattern and yield of butternuts (Cucurbita moschata) treatments revealed that treatment TRT 2 and TRT 3 produced fruits with a higher weight than from no pinching (TRT 1). The mean average weight was 0.457kg.

**Number of fruits per hectare:** There was significant (P<0.05) influence of pinching on the average number of fruits obtained (Table 2). The lowest number of fruits was obtained from TRT 1 which recorded 26 362 fruits. The highest number of fruits (47 452 fruits) was recorded from treatment TRT 4. Comparison of pinching to no pinching in this investigation reveals that the pinching treatments produced significantly more number of fruits than no pinching. The average number of fruits/ha was 36283.

**Average weight of fruits per plant:** The comparison of the treatment means reveal significant (P<0.05) differences on average weight of fruits per plant (Table 2). The highest average weight of fruits per plant was obtained from treatments TRT4 with 1.910 kg of fruits and followed by TRT 3 which recorded 1.614 kg. The lowest average weight of fruits per plant was obtained from treatments TRT 1 which recorded an average of 0.987 kg per plant. The mean average weight of fruits per plant was 1.485 kg.

**Number of fruits per plant:** As indicated in Figure 1, there were significant (P<0.05) differences for the pinching treatment with regard to number of fruits produced per plant. From treatments where pinching
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Gross yield: Effect of pinching on gross yield revealed significant differences (P<0.05) in this investigation (Figure 2). Comparison of pinching to no pinching reveal that pinching was significant higher than no pinching. The highest yields were recorded from TRT 3 and TRT 4 (21.2 t/ha and 17.91 t/ha respectively) while the least yields (10.95 t/ha) were recorded from TRT 1. The mean gross yield was 16.48 t/ha. TRT 1 and TRT 2 recorded gross yields that were below the mean.

Average percent marketable fruits: Data regarding influence of pinching on percentage marketable fruits are shown in Figure 3. Pinching treatments revealed significant (P<0.05) differences with treatment TRT 4 having the lowest percentage of marketable fruits (75.6%). The percentage marketable fruits for treatments TRT 1 and TRT 2 were not statistically different from each other and were both the highest at 87.2%. The mean percentage of marketable fruits was 82.32%.

Net marketable yield: Data pertaining to net marketable yield revealed that there were significant (P<0.05) differences among the means for the treatments investigated (Figure 4). Treatment TRT 1 recorded the lowest net marketable yield of 9.71 t/ha while the highest net marketable yield (18.80 t/ha) was recorded from TRT 4. Comparison of pinching to no pinching treatments reveals that the pinching was significant higher than no pinching. Mean net marketable yield was 14.62 t/ha.

DISCUSSION

These experiments, together with others reported in the literature, demonstrate that pinching have considerable potential for improving plant growth significantly. Statistical analyses showed that pinching increased number of stems, branches and female flowers. These results imply a positive influence of pinching to growth and development.

Effect on female flowers

Generally, all the treatments responded differently to effects of pinching. These differences are likely due to differences in the branching system of the plants with different pinching treatments. For instance, treatment 4 had the highest number of branches and as well as number of female flowers compared to other treatments. Treatment 1 had the lowest number of female flowers and also had the lowest number of branches. This shows a positive relationship between the flowering pattern of a plant and its branching pattern. This finding concurs with the findings from Riley (1998) who indicated that the number of branches has the tendency to stimulate the production of female flowers. The number of female flowers for the control was below the
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Figures not sharing a common letter differed significantly at 0.05 probability.

Key:
- TRT 1 - No pinching
- TRT 2 - Pinching at 2 nodes
- TRT 3 - Pinching at 4 nodes
- TRT 4 - Pinching at 6 nodes

**Figure 3.** Shows the %marketable fruits as influenced by pinching.

**Figure 4.** Shows the net marketable fruit yield as influenced by pinching.

mean average which might have been as a result of fewer branches on the plants leading to less development of female flowers.

**Effect on number of branches**

Pinching influenced the number of branches significantly. The differences in number of branches might be due to the age at which pinching was performed. The trend of the results show that the number of branches increased as pinching was delayed. Pinching at 2nd node resulted in a lower number of branches compared to pinching at 6th node which resulted in the highest number of branches. Generally the removal of terminal buds removes apical dominance resulting in redirecting of auxins to axillary bud/shoot
which later developed into branches. Dupriez and De Leener (1989); Lowes (2009); Iannotti (2009) observed that pinching encourages the development of more lateral shoots or branches. Central Coast gardening (2010) findings also indicated that pinching just above the first set of Basil (*Ocimum basilicum*) leaves encouraged nodes under the little leaves to grow more side branches. Removal of apical dominance enhances the growth of lateral branches because at the end of a branch of the plant, is the terminal bud where all growth develops and in that tip is a hormone that suppresses the growth of the side buds.

**Number of stems**

The number of stems per plant was influenced significantly (p<0.05) by pinching. Treatment 1 and 2 had the lowest number of stems and treatments 3 and 4 had the highest number of stems. The differences in the number of stems might be due to the differences in growth stage of a plant at the time of pinching. Stems increased with regards to the stage at which plants were pinched. Late pinching increased the number of stems, with the 6th node pinch recording the highest number of stems compared to pinching at early stages of a plant. Harriet (1980) asserted that the removal of the main growing point stimulates the development of axillary buds down the stem which grow into lateral branches, thus causing the plant to bush out. Pinching also increases main stem diameter making them solid (Rowell, 1981).

**Effect on gross yield**

Pinching increased the gross yields in treatments that were pinched compared to the control. Yields increased as pinching was delayed. The high yields obtained in pinched treatments could be due to the increase in branching, stem number and number of flowers as a result of pinching. For example, plants pinched at 6th node recorded the highest number of branches, stems and flowers which could have led to the increase in gross yield. Lowes (2009) asserted that pinching also known as stopping is the removal of the growing point of a stem to encourage lateral shoots or side branches which will eventually bear more flowers and increase yields.

**Effect on Average number of fruits/plant**

Average number of fruits per plant was high in plants that were pinched compared to the control. The average number of fruits increased as pinching was delayed. Pinching at a delayed stage also has positive effects on the number of fruits per plant compared to pinching earlier. Fruits were more in plants pinched at 4th node and 6th node. This could have been caused mainly by the increased number of female flowers and branches. Riley (1998) indicated that increased number of branches has the tendency to stimulate the production of female flowers. The more the female flowers the more the fruits produced per plant.

**Effect on Average number of fruits per hectare**

Pinching of plants in this experiment increased the number of average fruits per hectare. The average fruit per hectare was higher in plants that received pinching treatment compared to the unpinched plants. This could have been caused mainly by the increased number of female flowers and branches in the pinched plants as discussed earlier. Plants that were pinched at 4th node and 6th node recorded the high average fruits per hectare respectively. Thus pinching at a late stage had more effect than pinching at an earlier stage of plant growth.

**Effect on fruit weight/plant**

Generally, the number of fruits harvested in plants per treatment corresponded to the fruit weight gained. The greater the number of harvested fruits the higher the corresponding weight and vice versa. However, there were some instances where in some treatments more fruits were harvested but the corresponding weight was less compared to those in other treatments. For instance, plants pinched at 6th node recorded the highest number of average fruits harvested per plant but recorded the lowest average weights per plant compared to other treatments. The differences in weight could be due to nutrients availability or pinching effect. It could also be due to increase in vegetative growth (leaves and branches). Arin and Ankara (2001) when determining the effects of pinching on tomato plant growth, earliness and total yield led to conclusion that the practice results in early and quality fruit production. Pinching of the growing point of tomato plant, leaving 4 or 5 fruit produced good results.

**Effect % marketable yield and net marketable yield**

The selection of marketable fruits in this experiment was based on length and diameter ratio (fruit index), uniform shape, firmness, skin color (using the fruit color chart) and absence of growth and handling defects, no cracks, and no pitting. Shalaby and Hussein (1994) indicated that length/diameter ratio (LDR) values ≥4 indicate thicker skinned fruits, an attribute of good quality. Plants that received the pinching node recorded significantly higher number of net marketable fruits and % marketable yield. The causes of the high number of marketable fruits in pinched plants could be because of nutrient availability and due to pinching effects. According to Buczkowska (2001), pinching at early
growth stages increases the marketable yield to total yield ratio, fruit number, and the production of physiologically ripe fruits. The cause for the lower % marketable fruits in the control could be attributed to insufficient nutrients. This could have led to the development of small sized fruits below both local and export market standards. For the export market, butternut fruit should be straight and medium sized. Unmarketable fruits from the various treatments could have also been the result of harsh weather conditions such as heavy rains in the wet season and extreme high temperature which obstructs the activities of bees in pollination leading to the formation of misshapen fruits (Kelly et al., 2000). The sudden attack by Powdery mildews as a result of high humidity did not allow the plants to reach their full potential yield contributed to the low marketable yields obtained.

CONCLUSION

Pinching of plants influenced the growth, flowering pattern and yield of butternuts. In general, plant growth increased progressively with increase in the age and the time pinching was performed. Pinching influenced the growth of stems, branches and female flowers significantly. Generally yield was high in plants treated with pinching compared with plants which were not pinched. The trend showed that all treatments with pinching had yields higher than the average. Number of fruits per plant corresponded with the number of branches on the plant and the fruit weight gained. The greater the number of harvested fruits the higher the branches and the corresponding weight. The total yield and marketable yield increased with pinching treatments. Pinched plants recorded the highest number of marketable yields. Results from this study suggests that smallholder farmers can pinch their plants at a later stage of growth to encourage growth and development and increase yields. Indeed, farmers can pinch their plants at 6th node to attain maximum growth of branches and female flowers hence more fruits.

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REFERENCES


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