Research Article

Effect of terminal and axillary bud pruning on growth and yield attributes of okra (Abelmoschus esculentus L.) Under the climatic conditions of Quetta

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Abstract
This study aims to investigate how different pruning techniques, such as no pruning (controlled), terminal bud pruning, and axillary bud pruning, affect the growth and yield of okra. A randomized complete block design with three treatments and four replications was used to carry out the research work. The maximum and minimum number of days to flowering were observed in plants with terminal bud pruning and no pruning. In addition, maximum plant height was increased under axillary bud pruning, and the minimum was noted in terminal bud pruning. It was noted that pods per plant increased with terminal bud pruning, whereas they decreased with no pruning. The pod length was also exaggerated by pruning; a maximum pod length was noted in terminal bud pruning, whereas the minimum was observed in no pruning. Respectively, the maximum and minimum pod diameter were observed in plants with terminal bud pruning and in plants with no pruning. In addition, terminal bud pruning shows a higher single pod weight as compared to plants with no pruning. Pod weight per plant was highly affected by pruning, and the maximum weight was recorded in terminal bud pruning and the minimum in no pruning. A significant difference was observed in yield per hectare; plants under terminal bud pruning produced the maximum yield per hectare, while the minimum was noted with no pruning. The present study provided crucial evidence that terminal bud pruning in okra would be the best option for vegetable growers to produce maximum yield and financial benefit.

Keywords: Axillary; bud; flowering; okra, pods; pruning; terminal

Introduction
Okra (Hibiscus esculentus) belongs to the Malvaceae family and is one of the most important vegetable crops because of its nutritional value and germination in almost all types of soil and climatic conditions. It is a versatile crop appreciated for its delicious flavour and as a good source of various nutrients [1]. Okra is a rich source of vitamin C, proteins, carbohydrates, potassium, and calcium, which are necessary for the human body [2]. Being a
good source of different nutrients, using okra in a routine diet is essential for a healthy life [3, 4].

Pruning is the removal of plant parts, and it may include branches and shoots, but sometimes fruits, flowers, and roots may also be removed to divert food and energy to fruit-bearing parts of the plant [5]. Removal of the apical bud of Okra increases the number of fruits and fruiting branches per plant [6]. Pruning results in an increase in primary branches, which is due to breaking apical dominance [7]. Adequately pruned plants produce large and healthy fruits, which affect and increase the yield and quality of the fruits as compared to non-pruned plants [8].

Material and methods

This experiment was conducted from April to August in the years 2021 and 2022 at the Directorate of Vegetable Seed Production Farm, Agricultural Research Institute, Quetta, Balochistan (30° 10' 59.7720" N and 66° 59' 47.2272" E). The region has a semi-arid climate, with summers lasting from April to September and averaging 22°C to 28°C temperatures. The autumn season, which begins in September and lasts until mid-November, has an average temperature range of 12°C to 18°C. Between 18°C and 22°C was the region's average temperature from planting to harvesting. Randomized Complete Block Design (RCBD) was used with three treatments and four replications. Selected land for the experiment was cleaned, levelled, and thoroughly ploughed [10]. After land preparation and the addition of farm yard manure, plots were made according to design, and seeds were sown in rows. Plant-to-plant and row-to-row distances were maintained at 40 and 65 cm respectively, [12]. A local variety (Sabz Pari) was selected for this research experiment. A seed germination test was carried out in the laboratory to test the germination percentage of okra seeds. After 7 days of sowing, the crop was checked and thinned out at 40 cm. The plot size was 4.0 x 4.0 square meters, with a total of 12 plots. Drip irrigation system components were laid out according to an experimental design. A seed germination test was carried out before sowing, and 20 seeds of okra were selected for the germination test. Test results showed 94 to 95 percent germination. The details of the treatments are as follows:

T1: Controlled with no pruning
T2: Terminal bud pruning
T3: Axillary bud pruning

In T2, the terminal bud of the main stem was removed after 15 days of sowing. In T3, four axillary buds were removed after 15 days of sowing.

Results

Days to Flowering

Days to flowering were affected by pruning, and it was delayed in pruned plants (Table 1 & Fig. 1). Fewer days were observed till flowering in control, with no pruning (T1) (45.50), followed by axillary-pruned plants (T3) (49.25), while in terminal bud pruning (T2) (51.50), days were noted. Statistically, no significant difference was observed in the days to flowering, and it is confirmed that pruning doesn't affect the days to flowering. A delay in days to flowering may be due to the removal of the terminal and axillary buds of plants, which results in more lateral branch
initiation and requires more time for maturity and flowering initiation. The team of researchers obtained similar results in their experiment [13].

**Plant Height (cm)**

In all three treatments, a considerable amount of difference was observed in plant height (Table 1 & Fig. 1). The maximum plant height was recorded in axillary bud pruning (T3) (142.48 cm), followed by control (T1) (123.73 cm), and the minimum plant height was noted in terminal bud pruning (T2) (106.08 cm). A significant difference was observed in plant height. Pruning significantly affects the plant height, and it is due to the removal of apical parts because apical parts have auxin hormone, which promotes cell elongation. The removal of the apical bud reduces the height of plants and increases lateral branches and flowers. Similar results were obtained by researchers in 2017 [1].

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Days to Flowering</th>
<th>Plant Height (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>45.50</td>
<td>123.73</td>
</tr>
<tr>
<td>T2</td>
<td>51.50</td>
<td>106.08</td>
</tr>
<tr>
<td>T3</td>
<td>49.25</td>
<td>142.48</td>
</tr>
</tbody>
</table>

F test: *: P<0.05; **: P>0.05

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td>F test</td>
<td>0.43</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Table 1: Days to Flowering and Plant Height (cm)**

**Figure 1: Days to flowering and plant height (cm)**

**Pods per plant**

The number of pods per plant was also affected by pruning. A higher number of pods were produced in terminal bud pruning (T2) (18.75), followed by axillary bud pruning (T3) (18.00), and fewer numbers of pods were noted in the control (T1) (12.75) (Table 2 & Fig. 2). Pruning results in more lateral branches and flower production, which ultimately produce more pods per plant. It was confirmed that pruned plants produced more lateral branches compared to unpruned plants, and more branches and leaves promote higher photosynthesis and the translocation of food to the reproductive parts of the plants. Statistically, a non-significant difference was observed in pods per plant. Ali and his team obtained similar results in their experiment [13].

**Pod length (cm)**

The pod length per plant was significantly affected by pruning. According to the mean values, the longest pods were produced by...
terminal bud pruned plants (T2) (11.13 cm), followed by axillary bud pruned plants (T3) (10.33 cm), and the shortest pod length was recorded in no pruning (T1) (9.18 cm) (Table 2 & Fig. 2). An increase in pod length may be due to the production of more leaves, which provide more area for photosynthesis and the translocation of nutrients to pods and increase the overall pod size in pruned plants. In a similar study, researchers noted in their studies that fruit length increased due to pruning [14, 15].

Table 2: Pods per plant and pod length (cm)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pods per Plant</th>
<th>Pod Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>12.75</td>
<td>9.18</td>
</tr>
<tr>
<td>T2</td>
<td>18.75</td>
<td>11.13</td>
</tr>
<tr>
<td>T3</td>
<td>18.00</td>
<td>10.33</td>
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<tr>
<td>F test</td>
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<td>**</td>
</tr>
<tr>
<td>P-Value</td>
<td>0.73</td>
<td>0.00</td>
</tr>
</tbody>
</table>

F test: **: P<0.05; *: P>0.05

Figure 2: Pods per plant and pod length (cm)

Pod diameter (cm)
According to the mean data, the maximum pod diameter was noted in terminal bud pruning (T2) (6.10 cm), followed by axillary bud pruning (T3) (6.03 cm), and the lowest pod diameter was found in control (T1) (5.13 cm) (Table 3 & Fig. 3). Pod diameter in pruned plants might be due to the production of more branches and leaves, which provide more leaf area for photosynthesis, the production of food, and the translocation of nutrients to fruits. Statistically, the results were non-significant, and no clear difference was observed in pod diameter. Researchers obtained similar results in their experiments [1, 16].

Single pod weight (g)
No clear difference was noted among the treatments. The mean values of single pod weight show a slight difference that is not significant. The highest single pod weight was noted in terminal bud pruning (T2) (10.43 g), followed by auxiliary bud pruning (T3) (10.23 g), and the lowest single pod weight was noted in the control (T1) (9.40 g) (Table 3 & Fig. 3). Single pod weight was slightly affected by pruning, but statistically, all results were non-significant. Kabir found similar results in his study [14].
Table 3: Pod diameter (cm) and single pod weight (g)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pod Diameter (cm)</th>
<th>Single Pod Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>5.13</td>
<td>9.40</td>
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<td>T2</td>
<td>6.10</td>
<td>10.43</td>
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<tr>
<td>T3</td>
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</tbody>
</table>

F test: **: P<0.05; *: P>0.05

Figure 3: Pod Diameter (cm) and Single Pod Weight (g)

Pod weight per plant (g)
This parameter was highly affected by pruning, and the mean results showed a significant difference between the treatments. The highest pod weight per plant was produced by terminal bud pruning (T2) (193.68 g), followed by axillary bud pruning (T3) (184.83 g) and the lowest pod weight per plant was recorded in the control (T1) (119.10 g) (Table 4 & Fig. 4). The obtained results show the significance of pruning and its effects on yield per plant. An increase in yield per plant may be due to a decrease in plant height, which allows nutrients to be translocated towards vegetative growth and the production of more pods per plant, resulting in a higher yield. Statistical results revealed that there is a significant difference among the treatments. Similar results were obtained by researchers in their experiments [13, 17].

Yield per hectare (tons)
The mean data regarding yield per hectare showed significant differences among the treatments. The obtained mean data revealed that the highest yield was produced in terminal bud pruning (T2) (10.27 tons), followed by axillary bud pruning (T3) (9.23 tons), and the lowest yield was recorded in control (T1) (7.86 tons) (Table 4 & Fig. 4). These results revealed the importance of pruning and its significant effects on plant growth and production. Statistical analysis showed a significant difference between the treatments. Researchers obtained the same results in their research experiments [17, 18].
Table 4: Pods weight per plant (g) and yield per hectare (ton)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pod Weight per Plant (g)</th>
<th>Yield per Hectare (tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>119.10</td>
<td>7.86</td>
</tr>
<tr>
<td>T2</td>
<td>193.68</td>
<td>10.27</td>
</tr>
<tr>
<td>T3</td>
<td>184.83</td>
<td>9.23</td>
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</tr>
<tr>
<td>P-Value</td>
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</table>

F test: - **: P<0.05; *: P>0.05

Results and Discussion
The present study revealed the importance of pruning and its significant effects on different parameters of plant growth. Plant height, pod length, pod weight per plant, and yield per hectare were significantly affected by pruning. The maximum plant height was observed in axillary bud pruning (T3) (142.48 cm), followed by control (T1) (123.73 cm), and the minimum plant height was noted in terminal bud pruning (T1) (106.08 cm). The pod length was also affected by pruning, and the longest pods were observed in terminal bud pruned plants (T2) (11.13 cm), followed by axillary bud pruned plants (T3) (10.33 cm), and the shortest pod length was recorded in no pruning (T1) (9.18 cm). Similar results were noted in pod weight per plant, where the highest pod weight per plant was produced by terminal bud pruning (T2) (193.68 g), followed by axillary bud pruning (T3) (184.83 g), and the lowest pod weight per plant was recorded in the control (T1) (119.10 g). Main factor yield per hectare was significantly affected by pruning, and the maximum yield was obtained from terminal bud pruning (T2) (10.27 tons), followed by axillary bud pruning (T3) (9.23 tons), and the lowest yield was recorded in the control (T1) (7.86 tons). Similar results were obtained by different researchers around the world [1, 13, 14, 15, 17, 18].

Conclusion
The findings of this study indicate that pruning has a significant impact on almost all growth and yield parameters. The results showed that plants with terminal bud pruning produced a higher yield per hectare as compared to the other treatments.

Authors’ contributions
Conceived and designed the experiment: MA Babar & BA Bangulzai, Performed the experiment: SM Lehri, MB Ali, M Arif & S Ahmed, Analyzed the data: M Kashif & M Asif, Contributed reagents/materials: M Arif, MB Ali & S Ahmed, Wrote the paper: MA Babar & BA Bangulzai

References


