**Morphological and Nutritional responses ofPumpkin (*Cucurbita moschata*) to pruning at different node stages**

**Abstract**

In recent years, the practice of pruning has evolved into a complex approach for improving the growth, structure, and yield of crops. Cucurbitaceous plants have a vining habit, grow quickly, and branch widely, which are characteristics of their natural growth patterns. With the following concept, the current investigation was conducted at the Instructional cum Research Farm, Department of Horticulture, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali. The main purpose of this study was to investigate the morphological, nutritional and yield parameters as influenced by pruning. The treatments were: T1(Pruning of the primary vine at 10thnodestage),T2(Pruning oftheprimaryvineat12thnodestage),T3(Pruning of the secondary vine at 6th node stage), T4(Pruning of the secondary vine at 8th node stage), T5(Removal of all tertiary vines), T6(control without pruning). The study recorded the highest vine length (438.89 cm) and inter-nodal length (17.71 cm) of primary vine at harvest was found under T3whileT2 recorded the highest number of secondary vines (8.90) at harvest. The highest petiole length (27.34 cm) was recorded by T2 at harvest. With respect to nutritional characters, pruning showed significant changes, such as the highest vitamin A (2218.92 IU) and ascorbic acid (7.96 mg/100g) was recorded by T1 while T2 recorded highest total phenol content (86.35 mg/GAE/100gFW), in terms of total soluble solids content, T5 recorded the highest (5.97 ºBrix) value. The overall study revealed that pruning not only helped in enhancing overall morphological parameters but also had a significant effect on nutritional parameters. As pruning can be seen to enhance these parameters it can be suggested to the farmers of Assam to adopt it as a cultural practice.

**Keywords**: Pruning, nodes, vine, vitamin A, ascorbic acid, phenols, TSS

**Introduction**

One of the most popular cucurbitaceous vegetable crop in India, pumpkins are grown in a variety of agroclimatic situations and are prized for their high carotene content.According to archeological records, the genus *Cucurbita* L., which includes squash and pumpkins, is indigenous to America. Its culture dates back over 10,000 years and *Cucurbita pepo* L. seems to have been among the first domesticated species [1]. Pumpkin, like other cucurbits, has vines that bear female flowers approximately after every five to six male flowers [5]. Carotenoids, carbohydrates, flavonoids, minerals, amino acids, and phenolic compounds are abundant in the flesh of the pumpkin fruit, while the seeds are a particularly strong source of lipids, proteins, and minerals. About 20 kcal/100 g is the very low calorie content of the flesh.

One crucial factor influencing the success of Cucurbitaceae crops, such as pumpkin, is the quantity of vines per plant [7]. However, another crucial factor influencing fruit size, mass, and yield is the number of fruits produced per vine [11]. As a result, it is crucial to give a little attention for management of the cucurbit. Several techniques, such as vine and fruit pruning, can be used to control the number of vines per plant and the number of fruits per vine in cucurbits. Pruning affects the plant's capacity to bear or produce fruit, which in turn affects the plant's function. It establishes and enhances the plant's fruit-bearing capacity. Pruning drives or directs the sap flow to the fruit-bearing portion of the plant, forcing the vine or plant to produce higher-quality fruits. The pruning method and its uses in pumpkin are extremely uncommon because of the farmers' inadequate information and lack of experience. Keeping this point in view the following experiment was conducted.

The distribution of resources, light interception, disease susceptibility, and general production may all be hampered by this inherent vigour. In order to alter this growth trajectory, pinching involves carefully removing the terminal buds or apical meristems of plants at key points in their development. The development of reproductive organs is impacted, branching patterns are altered, and growth hormone distribution is redirected [24]. A combination of morphological and physiological concepts is used in the pinching technique. Pinching encourages the activation of lateral buds by preventing the apical meristem from dominating, which results in a more balanced growth distribution and may lessen excessive vegetative increase. This could therefore lead to better ventilation, light penetration, and fruit growth inside the plant canopy. Additionally, auxins and cytokinins, which are crucial for controlling growth, apical dominance, and lateral branching, can be affected by pinching. In addition to increasing fruit output in terms of both quality and quantity, pinching has demonstrated promise in terms of resource efficiency and disease control. However, depending on a number of variables, including crop species, growth stage, weather circumstances, and the particular production objectives, the consequences of pinching can differ [1].

**Materials and methods**

The study was carried out from October 2021 to April 2022 at the Instructional cum Research Farm, Department of Horticulture, Biswanath College of Agriculture, Assam Agricultural University, BiswanathChariali (26.7° N latitude and 90.5° E longitude and at 105 m above MSL). TheexperimentwaslaidoutonRandomizedblock design consisting of 6 treatments with 3 replicationssuch as T1(Pruning of the primary vine at10th node stage), T2(Pruning of the primary vine at 12th node stage), T3(Pruning of the secondary vine at 6th node stage), T4(Pruning of the secondaryvine at 8th node stage), T5(Removal of all tertiary vines), T6(control without pruning). Using secateurs, the plants were pruned when they reached the pruning stage in accordance with various treatments. To prevent node damage, the plants were cut above the node. Standard cultural procedures were followed to guarantee a strong crop stand, beginning with the experimental plot's preparation through careful ploughing, harrowing, and leveling.

The length of the primary vine (in cm), inter nodal length of the primary vine (in cm) and the number of secondary vines at time of harvest were among the morphological parameters that were noted. The nutritional parameters which were studied during the experiment were estimation of vitamin A, Ascorbic acid, total soluble solids and total phenol content.

**Estimation of Vitamin A**

Vitamin A was estimated using beta-carotene as a measurement tool. The process was taken from [25]. The fruit was smashed using a pestle and mortar, and 5 ml of its liquid was collected in a separating funnel. Then, 5 ml of juice was combined with 10 ml of petroleum ether and 10 ml of acetone, and thoroughly mixed. The lower surface developed a noticeable layer after mixing, which was thrown away. Only the topmost layer was collected and retained, and 100 ml of petroleum ether was added to finish the volume make-up. A separating funnel was used to extract 5 ml of fruit juice. Then, using petroleum ether as the blank, a spectrophotometer was used to record the optical density (O.D.) at 452 nm. The following formula was then used to estimate vitamin A, which was then expressed in international units (I.U.).

Vitamin A was estimated by using the formula

β carotene (μg/100g) = $\frac{O.D 13.9 x 10 x 100}{Wt of the sample 560 x 1000}$

Vitamin A (IU) = $\frac{Beta carotene (\frac{μg}{100g})}{0.6}$

**For estimation of Ascorbic acid content**

After obtaining 10 g of fruit sample, 4% oxalic acid was used to make up the volume before filtering. 100 ml volumetric flask was used to measure the ascorbic acid concentration using the visual titration method with 2, 6 dichlorophenol indophenol dye. The result was stated in milligrams per 100 g. The filtrate, which was prepared using two and a half dichlorophenol and indophenol, was titrated against the standard dye in ten milliliters. When the solution turned pink, that means filtrate has reached its end point and the readind was noted at that point [19].

Ascorbic acid (mg/100g) **=** $\frac{Titre value x Dye factor X Volume made up}{\begin{array}{c}Weight of the sample taken for estimation x \\Aliquot of sample taken for estimation\end{array}}$ X 100

\*Dye factor = 0.5/Titre value

**Estimation of total phenol content:** It was estimated by using the method given by [23] using Folin-Ciocalteu.

Total phenol (mg GAE/100gFW) = $\frac{Absorbance at A650nm X V X D.F}{\begin{array}{c}Weight of the sample taken for estimation x \\1000\end{array}}$

where, V= volume made up

 D.F= Dilution factor

**For estimation of total soluble solids (TSS)**

It was estimated using hand refractometer (model IK-218) and measured in ºBrix.

### The significance or non-significance of the analysis of variances was calculated by following the method described by [15]. The significance of difference between mean values of the parameters of the treatment was tested by computing critical difference (CD at5%) estimates.

**Results and Discussions**

1. **Morphological parameters influenced by pruning**
2. **Primary vine length (at harvest)**

As depicted in Table 1, T3 showed highest primary vine length (438.89cm) at harvest while T1 recorded the lowest primary vine length (114.50 cm) at harvest. The plants' ability to absorb adequate light and nutrients to support healthy growth and development may account for the longest primary vine in T3, which is the longest. Similar results in eggplant were reported by [14]. An increase in cell division and cell expansion in the inter-nodal length might have also contributed to the maximum vine length [10].

On the other hand, the lowest primary vine length of T1 might be due to the lack of phytohormones such as auxin which plays a major role in apical growth of the plants. The breakdown of apical dominance during pruning operations, on the other hand, inhibits apical growth and promotes the growth of subsequent branches [12]. In case of okra, growth and development were similarly promoted by removing the apical bud [13]. When all lateral branches were removed during pruning of the long melon, the primary vine's maximum length was noted since, according to [22], only the main vine would have access to the nutrients. Auxin levels decrease and cytokinin levels increase with the pruning of the main stem. Cytokinin causes the lateral shoots to enlarge.

1. **Inter-nodal length of primary vine (at harvest)**

Study of variance revealed significant differences in terms of inter-nodal length of primary vine at harvest as shown in Table 1. T3 showed the highest (17.71 cm) inter-nodal length of primary vine while the lowest inter-nodal length of primary vine was recorded under the treatment T1 (14.69 cm) at harvest. Pruning operations encourage controlled development by improving photosynthetic efficiency, which supports cell expansion in other plant parts by restricting the growth of unproductive plant parts. The present findings closely resemble the results of [26], [9], [3] and [21].

1. **Number of secondary vines and length of petiole (at harvest)**

Pruning affects the quantity of lateral branches and inhibits the growth of apical buds while encouraging the growth of secondary vines. As auxin present in the main stem is responsible for apical dominance, when pruned the effect of auxin is removed and it promotes the growth of lateral or secondary vines. Due to this reason there might be increase in number of secondary vines in the pruned treatments as compared to the unpruned ones [6]. The highest number of secondary vines was found under T2 (8.90) followed by T1 (7.46) as shown in Table 1.

On the other hand T6showed lowest (5.22) number of secondary vines (Table 1). Under this treatment the plants were left unpruned because of which the main stem was allowed to grow and there were very few number of lateral branches seen. The plausible reason might be because of apical dominance.

The length of the stalk that joins a leaf blade to the stem is known as the petiole length. Plants benefit from longer petioles because they enable leaves to reach for sunlight in crowded areas, encourage leaf flutter for air circulation and cooling, and might also increase light interception and photosynthetic efficiency which will help the plants for promoting more energy in producing higher yield. Studies revealed no direct relationship between pruning and petiole length but during this study the longest petiole length was recorded under T2 (27.34 cm) and the shortest petiole length was under T6 (18.44 cm).

**Table 1: Primary vine length, inter nodal vine length, number of secondary vines, petiole length at harvest**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Treatments** |  |  |
| **T1** | **T2** | **T3** | **T4** | **T5** | **T6** | **SEd±** | **C.D. (P=0.05)** |
| **Primary vine length (cm)** | 132.71 | 162.33 | 438.89 | 418.14 | 427.51 | 406.53 | 0.56 | 1.21 |
| **Inter nodal length of primary vine (cm)** | 15.96 | 16.10 | 17.71 | 15.35 | 16.47 | 15.63 | 0.23 | 0.50 |
| **Number of secondary vines** | 7.46 | 8.90 | 6.35 | 5.81 | 5.50 | 5.22 | 0.27 | 0.59 |
| **Petiole length (cm)** | 21.46 | 27.34 | 22.88 | 20.48 | 20.10 | 18.44 | 0.02 | 0.05 |

1. **Nutritional parameters influenced by pruning**

**Effect of pruning on vitamin A, ascorbic acid, total phenols and total soluble solids content in pumpkin**

The study revealed some significant differences among the pruning treatments on different nutritional parameters. It was observed that the highest vitamin A content was recorded by T1 (2218.92 IU) while the lowest was recorded by T6 (1925.76 IU),as for the ascorbic acid content T1 showed the highest (7.96 mg/100g) followed by T5 (6.56 mg/100g) and the lowest ascorbic acid content was recorded by T6 (5.46 mg/100g) as shown in Table 2.

Also the study of variance revealed that significant difference had been recorded in terms of total phenol content and total soluble solids content for different pruning treatments. The highest phenol content was recorded by T2 (86.35 mg GAE/100gFW) while T6 recorded the lowest (74.28 mg GAE/100gFW). In case of total soluble solids content T5 recorded highest (5.97 ºBrix) while T6 recorded the lowest (3.12ºBrix).

In studies, as revealed by [17] sweet gourd with up to five secondary vines clipped had higher levels of β-carotene. Furthermore, [8] discovered significant differences in the vitamin A content of pointed gourds cultivated with different trimming methods. Pruning treatments have been found to positively increase ascorbic acid (vitamin C) levels by a number of researches. Vitamin C levels were higher in the pruned plants as compared to unpruned plants [16]. The ascorbic acid content of sweet pepper plants that were pruned to a single branch was likewise greater [2]. According to the data described above, the ascorbic acid concentration was affected by the pruning treatments in the current investigation. One possible explanation for the higher ascorbic acid concentration seen under pruning therapy is the increased morpho-physiological features brought forth by pruning. Furthermore [18] discovered that cherry tomatoes have more ascorbic acid when stem trimming was done. Also significant differences were observed in terms of phenol content which might be due to higher metabolic activities because of pruning operation. The results obtained from the present investigation in terms of total soluble solids content are in line with the findings reported by [20] in cucumber and by [4] in muskmelon which suggests that the total soluble solids content, reducing sugars and starch content increased significantly along with the pruning treatments.

**Table 2: Vitamin A, Ascorbic acid, Total phenol and Total soluble solids content at harvest**

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameters** | **Treatments** |  |  |
| **T1** | **T2** | **T3** | **T4** | **T5** | **T6** | **SEd±** | **C.D. (P=0.05)** |
| **Vitamin A (IU)** | 2218.92 | 2150.64 | 1955.23 | 1977.19 | 2045.33 | 1923.88 | 0.81 | 1.70 |
| **Ascorbic acid (mg/100g)** | 7.96 | 5.73 | 6.32 | 5.61 | 6.56 | 5.46 | 0.23 | 0.50 |
| **Total phenol (mgGAE/100gFW)** | 83.47 | 86.35 | 85.16 | 79.53 | 80.58 | 74.28 | 0.42 | 0.91 |
| **Total soluble solids (º Brix)** | 3.98 | 4.57 | 5.01 | 4.33 | 5.97 | 3.12 | 0.44 | 0.95 |

**Conclusion**

The above study indicates that various pruning treatments had a significant impact on the morphological and nutritional characteristics of pumpkin. This study recommends that pruning practices can be used in pumpkin cultivation because they help improve physiological conditions, plant growth, and nutrient allocation; they also help to optimize sunlight exposure and airflow in the plants which aid in better conditions of the plants, reduce pest and disease incidence, and promote the development of high-quality fruit; and their implementation is likely to result in higher yields, improved fruit size, and better overall plant health.

Disclaimer (Artificial intelligence)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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