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Effect of Pruning on Morpho-physiological Characters and Yield of Pumpkin (*Cucurbita moschata*)

Barsha Nath [a++], B. P. Gautam [b#], N. Buragohain [b†*], R. K. Goswami [c#] and B. Bora [d†]

[a] Department of Horticulture, Assam Agricultural University, Jorhat-785013, Assam, India.
[b] Department of Horticulture, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali, 784176, Assam, India.
[c] Department of Crop Physiology, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali, 784176, Assam, India.
[d] Department of Plant Pathology, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali, 784176, Assam, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present study was carried out at the Instructional cum Research Farm, Department of Horticulture, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali with an aim to study the morpho-physiological characters and yield as influenced by pruning in

[++] PhD Scholar;
[#] Professor;
[†] Assistant Professor;
**Corresponding author: E-mail: nayanmoni.buragohain@aau.ac.in, nayanmoni.buragohain35@gmail.com;*

pumpkin. Pumpkin is an important commercial vegetable crop of Assam which is cultivated mainly during *rabi* season.The treatments were: T_1(Trimming of growing tip of the primary vine at 8th node stage), T_2(Trimming of growing tip of the primary vine at 10th node stage), T_3(Trimming of growing tip of the primary vine at 12th node stage), T_4(Trimming of growing tip of the secondary vine at 6th node stage), T_5(Trimming of growing tip of the secondary vine at 8th node stage), T_6(Removal of all tertiary vines), T_7(Retention of two tertiary vines) and T_8(control without pruning). The study revealed that among the treatments, T_4 recorded the highest primary vine length and inter-nodal length of primary vine at 60, 90 DAS and at 1st harvest. Number of primary vine was found to be highest under T_5 whileT_3 recorded maximum number of secondary vines, inter-nodal length of secondary vines, the highest total leaf chlorophyll content, relative leaf water content, leaf area index and maximum fruit yield. Therefore, trimming of growing tip of the primary vine at 12th node stage can be suggested for pumpkin to get maximum yield.

Keywords: Trimming; node stage; vine; pumpkin; morphological; physiological; yield.

1. INTRODUCTION

The ancestors of pumpkin (*Cucurbita moschata*) are from Mexico and Peru. The crop can thrive in both hemispheres' tropics and is tolerant to warm weather. According to botany, the pumpkin's fruit is a variety of berry called a pepo and is regarded as extremely valuable vegetable. With chromosomal number 2x=40, pumpkin is an allopolyploid [1]. A relatively fertile, well-drained soil is necessary for growing pumpkin. Medium-textured soils with good internal drainage and a high water-holding capacity produce the highest yields. They can be grown on a variety of soils, though it is not advised to use heavy clay soils. Although they are delicate to salinity and acidity, they can thrive in soils that range from mildly acidic (pH 6.8) to moderately alkaline (pH 8.0).

Pumpkins are hardy, so even if a large number of leaves or a significant piece of the vine are lost, injured or removed, the plant will quickly sprout new secondary vines to replace those that were lost [2]. Although the productivity and quality of fruits depends on different factors but proper vine management of the crop ha s positive influence of different morpho-physiological qualities which in turn increase the yield and quality of the fruits.

The production of auxin in the main stem continues to proceed without shoot pruning. Because of apical dominance there will be longer vegetative phase and inhibition of flowering time of the plant. A plant's function is impacted by pruning since it has an impact on the plant's ability to bear or produce fruit. It establishes and improves the plant's ability to produce fruits. By pruning, the plant or vine is forced to produce fruits of higher quality by having the sap flow driven or directed towards the part of the plant that bears fruit. Pruning also helps in removing non-productive parts which in turn helps in diverting the energy into the productive parts which are the fruits and helps in increasing the production. Also the quality of the fruits will be better as because of pruning there will be less canopy and better light penetration which will aid in proper size and growth of the fruits.

Due to the farmers' poor information and limited knowledge, the pruning technique and its applications in pumpkin are very rare. Considering the above facts the research work was conducted in Assam condition to find out the suitable pruning operation which will help in the overall increase in yield of pumpkin.

2. MATERIALS AND METHODS

The investigation was conducted at the Instructional cum Research Farm, Department of Horticulture, Biswanath College of Agriculture, Assam Agricultural University, Biswanath Chariali (26.7° N latitude and 90.5° E longitude and at 105 m above MSL) from October, 2021 to April, 2022. The experiment was laid out on Randomized block design consisting of 8 treatments with 3 replications such as T_1(Trimming of growing tip of the primary vine at 8th node stage), T_2(Trimming of growing tip of the primary vine at 10th node stage), T_3(Trimming of growing tip of the primary vine at 12th node stage), T_4(Trimming of growing tip of the secondary vine at 6th node stage), T_5(Trimming of growing tip of the secondary vine at 8th node stage), T_6 (Removal of all tertiary vines), T_7 (Retention of two tertiary vines) and T_8 (control without pruning) by using the same variety of pumpkin. Pruning was done when the plants reached their pruning stage according to different treatment using secateurs and was cut

above the node to avoid any injury to the node. In order to ensure a healthy crop stand standard cultural practices were performed starting with the preparation of experimental plot by thorough ploughing followed by harrowing and levelling. Then the whole plot was divided into 24 numbers of plots with 3 replications having 8 plots each. Each plot/bed was prepared maintaining a size of 9 m x 4.5 m. Then pits were dug of size 30 cm^3 and were filled with mixture of cow dung and top soil. Seeds were sown in the pits with spacing of 3m x 1.5 m. At first 2-3 seeds were sown in each pit and later on thinning was done and the healthiest plant was kept in each pit.

Morphological parameters such as length of the primary vine (cm), inter-nodal length of the primary and secondary vine (cm), number of primary and secondary vines at 60, 90 days after sowing (DAS) and at 1st harvest were recorded with the help of measuring tape. For the physiological parameters total leaf chlorophyll content (mg g^{-1}fw) was measured at 60 and 90 DAS with the help of spectrophotometer and was calculated by the formulae:

Total chlorophyll = $[\mathbf{20.2}(\mathbf{A}_{645}) + \mathbf{8.02}(\mathbf{A}_{663})]\ \mathbf{x}\ \mathbf{V}/(\mathbf{1000\ x\ W})$ mg g^{-1}fw

Where,

A_{645} and A_{663} = Optical density value at 645 nm and 663 nm wavelength of light
W = Fresh weight of leaf sample (g)
V = Final volume of chlorophyll extract in DMSO (ml)

Relative leaf water content (%) at 60 and 90 DAS was calculated by the formulae:

Relative Leaf Water Content (RLWC)=Fresh weight – Dry weight/Turgid weight − Dry weight x100

For Leaf area index, three different sized leaves were taken at 60 and 90 days after sowing from three tagged plants and the leaf area was measured using a digital Leaf Area Metre (model-Bionics an ISO 9001-2000 Company). Then the average was computed and it was recorded as the area of individual leaf (cm^2). The number of functional leaves were counted for the three tagged plants and it was multiplied with the individual leaf area as determined earlier to get the total leaf area per plant and Leaf area index was calculated by using the following formulae:

Leaf area index = Total leaf area per plant/Ground coverage area

Yield parameters such as fruit yield per plant and fruit yield per hectare were recorded. Observation made during field experimentation and data obtained from laboratory determinations were subjected to analysis of variance. Significance or non-significance of the variance due to treatments was determined by calculating the respective 'F' values by following the method described by Panse and Sukhatme [3]. The significance of difference between mean values of the parameters of the treatment was tested by computing critical difference (CD at 5%) estimates.

3. RESULTS AND DISCUSSION

3.1 Effect of Pruning on Morphological Parameters

3.1.1 Length of primary vine

The findings presented in Table 1 show that pruning had significant effect on length of primary vine. The highest primary vine length (262.67, 361.56 and 438.89 cm) at 60, 90 DAS and at 1st harvest respectively was found under the treatment T_4 while the lowest was recorded under the treatment T_1 (112.42, 115.42 and 114.50 cm) at all the three stages *i.e* 60, 90 DAS and at1st harvest. The highest primary vine length inT_4 (trimming of growing tip of the secondary vine at 6th node stage) could be explained by the fact that plants absorbing enough nutrients and light to enable healthy growth and development, thus increasing the length. In eggplant [4] reported similar findings. According to Krishnamoorthy and Sandooja [5] the maximum vine length may also be ascribed to an increase in cell division and cell enlargement which might be another factor that promotes a larger inter-nodal length and, in turn, a longer vine length. The shortest primary vine length in T_1(trimming of growing tip of the primary vine at 8th node stage) might be plausible as a result of the vines' decreased auxin concentration [6]. Auxin, a hormone which promotes growth, is responsible for apical dominance, which encourages apical growth in plants. However, when pruning operations are carried out, apical dominance breaks down which reduces apical growth and encourages the growth of lateral branches. Removing the apical bud also encouraged growth and development in okra [7]. In long melon, the maximum

length of primary vine was recorded when pruning was done by removal of all lateral branches as flow of nutrients will be available only to the main vine as reported by Singh et al. [8]. When the main stem is pruned, concentration of auxin falls while concentration of cytokinin rises. The expansion of lateral shoots is induced by cytokinin.

3.1.2 Inter-nodal length of primary and secondary vine

The inter-nodal length was also affected due to pruning (Table 1). The highest inter-nodal length of the primary vine was recorded by T_4(14.62 cm) at 60 DAS while T_1recorded the lowest (13.13 cm) inter-nodal length of primary vine. Similarly, T_4 recorded the highest inter-nodal length of the primary vine (16.20 cm and 17.71 cm, respectively) at 90 DAS and at 1st harvest and T_1 recorded under the lowest (14.42 and 14.69 cm at 90 DAS and 1st harvest), respectively. By limiting the growth of unproductive plant parts, pruning operations promote regulated growth by enhancing photosynthetic efficiency, which in turn promotes cell expansion in other plant parts. This is in close proximity with the findings of Yu et al. [9]; Jat [10]; Coggins and Lovatt [11]; Singh et al. [12]; Mardhiana et al. [6].

While measuring inter-nodal length of secondary vine, the highest (13.74 cm) was recorded by the treatment T_3 at 60 DAS which was statistically at par with T_5 (13.62 cm) and T_2 (13.35cm). Similarly, at 90 DAS and at 1st harvest the treatment T_3 recorded the highest (15.18 cm and 16.4 cm respectively) while retention of two tertiary vines (T_7) resulted in the lowest inter-nodal length of secondary vine (10.68, 10.93 and 11.26 cm) at 60,90 DAS and at 1st harvest, respectively .The highest inter-nodal length of the secondary vine under T_3 might be attributed to larger cytokinin concentration that encouraged more cell division, which resulted in longer length of secondary vine. This supports the findings of Coggins and Lovatt [11] which explained that by inhibiting auxin concentration, cytokinin concentration increased and extension of secondary vines was subsequently improved.

3.1.3 Number of primary and secondary vine

Table 2 revealed that the number of primary vines and secondary vines exhibited significant variation among the different pruning treatments. At 60, 90 DAS and at 1st harvest the highest (5.47, 5.77 and 6.30) number of primary vines was recorded by T_5. On the other hand, lowest (3.30, 4.61 and 5.39) number of primary vines was recorded by T_8 at 60, 90 DAS and at 1st harvest, respectively. T_3 at 60, 90 DAS and at 1st harvest recorded the highest (7.63, 8.59 and 8.90) respectively, while the lowest (3.70, 4.06 and 5.22) secondary vine number was recorded by T_8 at 60, 90 DAS and at 1st harvest. This might be possible because pruning was not performed in T_8 which resulted in increase of primary vine but no lateral branches were produced as apical dominance was present. Since pruning prevents the growth of apical buds and promotes the development of secondary vines, it also has an effect on the number of lateral branches. Pruning of the primary vine was performed in treatment T_3, which might have resulted in increasing number of secondary vines as apical dominance was inhibited because pruning suppresses apical dominance [13].

3.2 Effect of Pruning on Physiological Parameters

3.2.1 Total leaf chlorophyll content

A perusal of data presented in Table 3 indicated that the total leaf chlorophyll content was significantly affected by different pruning treatments. After 60 days of sowing T3 recorded the highest (1.83 mg g^{-1}fw) total leaf chlorophyll content which was significantly at par with T6 (1.79 mgg^{-1}fw). The superiority was maintained by T3 at 90 DAS also with the highest (2.08 mg g^{-1}fw) total leaf chlorophyll content followed by T6 (1.95 mg g^{-1}fw) and T2 (1.94 mg g^{-1}fw) while T8 recorded the lowest (1.44 and 1.71 mg g^{-1}fw) at 60 and 90 DAS. Similar findings were reported by Ahmad et al. [14] in tomato and Gupta et al. [15] in pointed gourd where maximum chlorophyll content was found under pruned plants as compared to the unpruned plants. The green leaves are the major factor contributing in photosynthesis, according to Xu and Zhou [16]. The vegetative growth is limited under pruning operations which makes light to penetrate easily in the inner canopy leading to more dry matter production which in turn increases the photosynthetic efficiency [17]. Lowest chlorophyll content was found in control which might be due to the fact that due to dense canopy light penetration was less and less chlorophyll was produced by the leaves.

3.2.2 Relative leaf water content

Significant difference was noticed forrelative leaf water content (Table 3). The highest relative leaf water content was recorded by T_3 (78.11%) followed by T_2 (75.62%) and T_1 (73.28%) while the lowest (69.69%) was by T_8 at 60 DAS. Similarly, T_3 recorded the highest (86.15%) relative leaf water content at 90 DAS whereas, T_8recorded the lowest (73.78 %) relative leaf water content with T_6 (74.23%) at par. The relative leaf water content is one of the main determinants of the water condition of the plant body. It maintains equilibrium between a plant's water intake and transpiration rate [18]. Preece and Read [17] opined that pruning can reduce vegetative growth and increase light penetration into the inner canopy, but it also raises the temperature, which results in water loss. However, it was discovered from the current investigation that because of pruning on the main stem, T_3 resulted in more number of secondary vines and more number of leaves, which might have resulted in a dense canopy and less light penetration, resulting in higher relative leaf water content. The economic yield was substantially impacted by relative leaf water content as reported by Ibrahim et al. [19].

Table 1. Effect of pruning on length of primary vine, inter-nodal length of primary and secondary vine at 60, 90DAS and at 1st harvest

Treatment	Length of the primary vine(cm)			Inter-nodal length of primary vine(cm)			Inter-nodal length of secondary vine(cm)		
	60 DAS	90 DAS	At 1st harvest	60 DAS	90 DAS	At 1st harvest	60 DAS	90 DAS	At 1st harvest
T_1	112.42	115.42	114.50	13.13	14.42	14.69	11.30	13.85	14.44
T_2	131.38	134.64	132.71	13.59	15.90	15.96	13.35	14.37	15.59
T_3	161.24	163.47	162.33	14.17	15.14	16.10	13.74	15.18	16.40
T_4	262.67	361.56	438.89	14.62	16.20	17.71	12.54	13.54	13.51
T_5	245.99	355.00	418.14	13.33	14.81	15.35	13.62	13.48	14.62
T_6	237.75	348.75	427.51	14.52	15.54	16.47	12.02	12.62	14.41
T_7	250.70	344.73	421.73	14.28	15.65	15.95	10.68	10.93	11.26
T_8	221.27	336.53	406.53	13.15	14.69	15.63	11.28	12.76	12.83
S.Ed±	0.45	0.55	0.56	0.06	0.20	0.23	0.36	0.32	0.26
C.D. (P=0.05)	1.12	1.18	1.21	0.13	0.42	0.50	0.77	0.69	0.56

T_1: Trimming of growing tip of the primary vine at 8th node stage, T_2: trimming of growing tip of the primary vine at 10th node stage, T_3: trimming of growing tip of the primary vine at12th node stage, T_4: trimming of growing tip of the secondary vine at 6th node stage, T_5: trimming of growing tip of the secondary vine at 8th node stage, T_6: removal of all tertiary vines, T_7: retention of two tertiary vines and T_8: control without pruning.

Table 2. Effect of pruning on number of primary and secondary vines at 60, 90 DAS and at 1st harvest

	Number of primary vines			Number of secondary vines		
Treatment	60DAS	90DAS	At 1st harvest	60DAS	90DAS	At 1st harvest
T_1	3.42	4.66	5.86	6.74	7.73	8.63
T_2	5.23	5.60	5.91	5.48	7.16	7.46
T_3	4.54	5.69	6.07	7.63	8.59	8.90
T_4	3.86	4.68	4.95	4.34	5.41	6.35
T_5	5.47	5.77	6.30	4.47	4.94	5.81
T_6	3.68	5.10	5.30	4.52	5.09	5.50
T_7	5.15	5.38	5.78	5.22	6.06	6.95
T_8	3.30	4.61	5.39	3.70	4.06	5.22
SEd±	0.30	0.22	0.26	0.33	0.44	0.27
C.D. (P=0.05)	0.64	0.47	0.56	0.71	0.94	0.59

T_1: Trimming of growing tip of the primary vine at 8th node stage, T_2: trimming of growing tip of the primary vine at 10th node stage, T_3: trimming of growing tip of the primary vine at 12th node stage, T_4: trimming of growing tip of the secondary vine at 6th node stage, T_5: trimming of growing tip of the secondary vine at 8th node stage, T_6: removal of all tertiary vines, T_7: retention of two tertiary vines and T_8: control without pruning

Table 3. Effect of pruning on total leaf chlorophyll content, relative leaf water content and leaf area index at 60 and 90 DAS

Treatment	Total leaf chlorophyll content (mg g^{-1}fw)		Relative leaf water content (%)		Leaf area index	
	60 DAS	90 DAS	60 DAS	90 DAS	60 DAS	90 DAS
T_1	1.55	1.84	73.28	83.99	1.64	1.82
T_2	1.76	1.94	75.62	85.56	1.75	1.85
T_3	1.83	2.08	78.11	86.15	1.87	1.96
T_4	1.54	1.85	71.39	79.37	1.54	1.59
T_5	1.63	1.91	72.25	80.99	1.63	1.74
T_6	1.79	1.95	70.29	74.23	1.61	1.66
T_7	1.59	1.86	72.49	77.29	1.43	1.58
T_8	1.44	1.71	69.69	73.78	1.35	1.46
SEd ±	0.02	0.02	0.40	0.42	0.05	0.11
C.D. (P=0.05)	0.06	0.05	0.87	0.91	0.12	0.25

T_1: Trimming of growing tip of the primary vine at 8thnode stage, T_2: trimming of growing tip of the primary vine at 10th node stage, T_3: trimming of growing tip of the primary vine at 12th node stage, T_4: trimming of growing tip of the secondary vine at 6th node stage, T_5: trimming of growing tip of the secondary vine at 8th node stage, T_6: removal of all tertiary vines, T_7: retention of two tertiary vines and T_8: control without pruning

3.2.3 Leaf area index

Leaf area index which was measured at 60 and 90DAS also revealed to be significantly affected by different pruning treatments (Table 3). Maximum leaf area index was recorded in T_3(1.87 and 1.96) while the minimum (1.35 and 1.46) was recorded in T_8 at both 60 and 90 DAS. Higher number of leaves results in higher leaf area index as leaves are the key component contributing to photosynthesis as they contain stomata. These findings are consistent with the present investigation. The highest leaf area index was recorded by treatment T_3 at both 60 and 90 days after sowing. In bottle gourd more number of leaves, total leaf area and leaf area index was recorded highest when pruning was done on secondary branch at 6th node stage [20]. Ekwu et al. [21]; Mardhiana et al. [6] also reported similar results in cucumber as they found that the plants which were pruned on main stem recorded highest number of leaves. Highest number of secondary vines under T_3 might be the reason for increase in number of leaves per vine in the current investigation. As reported by Fischer et al. [22] when leaf-fruit ratio is increased, it simultaneously results in higher number of fruits and more carbohydrate content. Pruning helps in controlling the plant growth, number of vines, leaves *etc.* which is helpful for the plant in yielding better and also checks the plant's health but when plants are kept in their natural state they show uncontrolled growth and also there is decrease in yield [11].

3.3 Effect of Pruning on Yield Per Plant and Per Hectare

As depicted in Table 4, pruning had significant influence over fruit yield per plant (kg) and fruit yield per hectare (t/ha). Among the treatments, T_3 recorded the highest fruit yield per plant (15.47 kg) and fruit yield per hectare (27.88 t/ha) while T_8 recorded the lowest fruit yield per plant (8.57 kg) and fruit yield per hectare (15.48 t/ha). The highest production seen under the pruned plants may have been caused by larger or more number of fruits. This is consistent with the research done on cucumber by Shivaraj et al. [23]. By allowing plants adequate light exposure, pruning boosted photosynthesis, which in turn increased source to sink ratio and raised the yield. Tomato and bitter gourd plants that had been pruned produced more fruit than the unpruned ones [24], [25] respectively. According to Paksoy and Akella [26] pruning led to a reduction in the amount of wasted fruit, which raised the marketable yield of eggplant. When plants were pruned to four stems in greenhouse grown sweet pepper, fruit yield increased as compared to unpruned plants [27]. Similar results were found in capsicum by Shetty and Manohar [28] and in chilli by Laxman and Mukherjee [29].

Table 4. Effect of pruning on fruit yield per plant (kg) and fruit yield per hectare (t/ha)

Treatments	Fruit yield (kg/plant)	Fruit yield (t/ha)
T_1	13.40	24.19
T_2	11.85	21.36
T_3	15.47	27.88
T_4	12.61	22.78
T_5	11.16	20.18
T_6	11.10	20.05
T_7	10.28	18.55
T_8	8.57	15.48
SEd ±	0.03	0.02
C.D (P=0.05)	0.06	0.05

T_1: Trimming of growing tip of the primary vine at 8thnode stage, T_2: trimming of growing tip of the primary vine at 10th node stage, T_3: trimming of growing tip of the primary vine at 12th node stage, T_4: trimming of growing tip of the secondary vine at 6th node stage, T_5: trimming of growing tip of the secondary vine at 8th node stage, T_6: removal of all tertiary vines, T_7: retention of two tertiary vines and T_8: control without pruning

4. CONCLUSION

The study revealed that different pruning treatments significantly affected the morpho-physiological characters and yield of Pumpkin.Trimming of growing tip of the primary vine at 12th node stage (T_3) produced maximum yield with better morpho-physiological condition of the plant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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