Original Research Article

Effect of pruning on morpho-physiological characters and yield of pumpkin (*Cucurbita moschata*)

ABSTRACT

The present study was carried out at the Instructional cum Research Farm, Department ofHorticulture, Biswanath College of Agriculture, Assam Agricultural University, BiswanathCharialiwithanaimtostudythemorpho-physiologicalcharactersand yield as influencedbypruning in pumpkin. Pumpkin is an important vegetable crop in Assam and it is available throughout the year..The treatments were: T_1(Trimming of growing tip of the primary vine at 8thnodestage),T_2(Trimmingof growingtipof theprimaryvineat10thnodestage),T_3(Trimming of growing tip of the primary vine at 12th node stage), T_4(Trimming of growingtip of the secondary vine at 6th node stage), T_5(Trimming of growing tip of the secondaryvine 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_4recordedthe highest primary vine length and inter-nodal length of primary vine at 60, 90 DAS and at 1st harvest. Number of primaryvine was found to be highest under T_5 whileT_3recorded 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,nodestage,vine, pumpkin,morphological, physiological,yield.

1. INTRODUCTION

The ancestors of pumpkin (*Cucurbita moschata*) are from Mexico and Peru. The crop canthrive in both hemispheres' tropics and is tolerant to warm weather. According to botany, thepumpkin's fruit is a variety of berry called a pepo and is regarded as extremely valuablevegetable. 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 thehighest yields. They can be grown on a variety of soils, though it is not advised to use heavyclay soils. Although they are delicate to salinity and acidity, they can thrive in soils that rangefrommildlyacidic(pH 6.8)tomoderatelyalkaline(pH8.0).

Pumpkins are hardy, so even if a large number of leaves or a significant piece of the vine arelost, injured or removed, the plant will quickly sprout new secondary vines to replace thosethat were lost [2]. Although the productivity and quality of fruits depends ondifferent factors but proper vine management of the crop has positive influence of differentmorpho-physiologicalqualitieswhich inturnincrease theyieldand qualityofthefruits.

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 Aplant'sfunctionisimpactedby pruningsinceithasanimpactontheplant'sabilitytobearor 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 ordirected towards the part of the plantthatbearsfruit.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 informationandlimitedknowledge,thepruningtechniqueanditsapplicationsinpumpkinareveryrare.Considering the above factsthe 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. MATERIALSANDMETHODS

The investigation was conducted 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) from October,2021toApril,2022.TheexperimentwaslaidoutonRandomizedblock design consisting of8 treatments with 3 replicationssuch as T_1(Trimming of growing tip of the primary vine at8th 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 growingtip of the secondary vine at 6th node stage), T_5(Trimming of growing tip of the secondaryvine 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. Pruningwasdonewhentheplantsreachedtheirpruningstageaccordingtodifferenttreatment using secateurs and wascutabovethenodeto avoid any injury to the node.In order to ensure ahealthy crop stand standard cultural practices were performed starting with the preparation ofexperimental plot by thorough ploughing followed by harrowing and levelling. Then thewhole plot was divided into 24 numbers of plots with 3 replications having 8 plots each. Eachplot/bed was prepared maintaining a size of 9 m x 4.5 m. Then pits were dug of size 30 cm^{3}and werefilled with mixture of cow dung and top soil.Seeds were sown in the pits with spacing of 3m x 1.5 m. Atfirst2-3 seeds were sown in eachpitandlateronthinningwasdone andthe healthiestplantwaskeptineachpit.

Morphological parameters such as length of the primary vine (cm), inter-nodal length of theprimary and secondary vine (cm), number of primary and secondary vines at 60, 90 days aftersowing (DAS)andat1stharvestwere recorded with the help of measuring tape. Forthephysiologicalparameterstotalleafchlorophyll content (mg g^{-1}fw) was measured at 60 and 90 DAS with the help of spectrophotometer and was calculated by the formulae

$$\textbf{Total chlorophyll} = [20.2(A_{645}) + 8.02(A_{663})]\ xV/(1000xW)\ mg\ g^{-1}fw$$

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 bythe formulae

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

Leaf area indexwas 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). Then the number of functional leaf was 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. Leaf area index was calculated by dividing the total leaf area per plant and ground coverage area at 60 and90 DAS.Yield parameters such as fruit yield per plant and fruit yield per hectare were recorded. Observation made during field experimentation and dataobtainedfromlaboratory determinationsweresubjectedtoanalysisofvariance.Significance or non-significance of the variance due totreatments was determined by calculating the respective 'F' values by following the methoddescribedby [3].The significanceof differencebetweenmeanvalues of the parameters of the treatment was tested by computing critical difference (CD at5%)estimates.

3 RESULTS AND DISCUSSION

3.1Effect of pruningon morphological parameters

3.1.1 Length of primary vine

The findings presented in Table1show 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_4while the lowest was recorded under the treatment T_1 (112.42, 115.42and114.50 cm)at all thethreestages *i.e*60,90 DASand at1stharvest.The highest primary vine length inT_4 (trimming of growingtip of the secondary vine at 6th node stage)could be explained by the fact that plants absorbing enough nutrients and lightto enable healthy growth and development, thus increasingthelength. In eggplant [4] reported similar findings. According to [5] themaximumvinelengthmayalsobeascribedtoanincreaseincelldivisionandcell enlargement which might be another factor that promotes a larger inter-nodal length and, inturn, 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 oflateralbranches.Removingtheapicalbudalsoencouragedgrowthanddevelopmentinokra [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 asreported by [8]. When the main stem is pruned, concentration of auxin fallswhileconcentrationofcytokininrises.Theexpansionoflateralshootsisinducedbycytokinin.

3.1.2 Inter-nodal length of primary and secondary vine

The inter-nodal length was also affected due topruning(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_4recorded the highestinter-nodal length of the primary vine (16.20 cmand 17.71 cm, respectively) at 90 DASand at 1st harvestand T_1 recorded under the lowest (14.42 and 14.69 cm at90 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 [9], [10], [11], [12], [6].

While measuring inter-nodal length of secondary vine, the highest (13.74 cm) was recorded by the treatment T_3at 60 DASwhich was statistically at parwith T_5(13.62 cm) and

T_2(13.35cm).Similarly,at 90 DASand at 1st harvest the treatment T_3 recorded thehighest(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) at60,90 DAS and at 1st harvest, respectively .The highest inter-nodal length of the secondary vine under T_3might beattributed to larger cytokinin concentration that encouraged more cell division, which resulted in longer length of secondary vine. This supports the findings of [11]whichexplainedthatbyinhibitingauxinconcentration,cytokininconcentration increased and extension of secondary vines was subsequently improved.

Table1. Effect of pruning on length of primary vine, inter-nodal length ofprimaryandsecondaryvineat60,90DASandat1st harvest.

Treatment	Lengthoftheprimary vine(cm)			Inter-nodal length ofprimaryvine(cm)			Inter-nodal length ofsecondaryvine(cm)		
	60 DAS	90 DAS	At1st harvest	60 DAS	90 DAS	At1st harvest	60 DAS	90 DAS	At1st 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 8thnode stage, T_2: trimming of growingtip of the primary vine at 10th node stage, T_3: trimming of growing tip of the primary vine at12thnodestage,T_4: trimmingofgrowingtipofthesecondaryvineat6thnodestage,T_5: trimming of growing tip of the secondary vine at 8th node stage, T_6: removal of all tertiaryvines,T_7: retentionoftwotertiaryvinesandT_8: controlwithoutpruning.

3.1.3 Number of primary and secondary vine

Table 2 revealed that the number of primary vines and secondary vinesexhibited significant variation among thedifferent 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_3at 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 recordedby T_8at 60,90DASand at1stharvest.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 pruningprevents the growth of apical buds and promotes the development of secondary vines, it alsohas 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 wasinhibited because pruningsuppressesapicaldominance[13].

Table2.Effectofpruningonnumberofprimaryandsecondaryvinesat60, 90DASandat1stharvest.

Treatment	Numberofprimaryvines			Numberofsecondary vines		
	60DAS	90DAS	At1stharvest	60DAS	90DAS	At1stharvest
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 8thnode stage, T_2: trimming of growingtip of the primary vine at 10th node stage, T_3: trimming of growing tip of the primary vine at12thnodestage,T_4: trimmingofgrowingtipofthesecondaryvineat6thnodestage,T_5: trimming of growing tip of the secondary vine at 8th node stage, T_6: removal of all tertiaryvines,T_7: retentionoftwotertiaryvinesandT_8: controlwithoutpruning

3.2 Effect of pruningon physiological parameters

3.2.1 Total leaf chlorophyll content

A perusal ofdata presented in Table 3indicatedthat thetotal leaf chlorophyll content was significantly affected by different pruning treatments.After 60 days of sowing T_3recordedthe highest (1.83 mg g^{-1}fw) total leaf chlorophyll content which was significantly at par with T_6 (1.79 mgg^{-1}fw). The superiority was maintained by T_3 at 90 DAS also with the highest (2.08 mg g^{-1}fw) total leafchlorophyll content followed by T_6 (1.95 mg g^{-1}fw) and T_2 (1.94 mg g^{-1}fw) whileT_8recorded the lowest (1.44 and 1.71 mg g^{-1}fw) at 60 and 90 DAS. Similarfindings were reported by [14] in tomato and [15] in pointed gourd where maximum chlorophyll content was found under pruned plants ascompared to the unpruned plants. The green leaves are themajor factor contributing in photosynthesis, according to [16]. The vegetative growth is limited under pruning operations which makes light to penetrate easily in the innercanopy leading to more dry matter production which in turn increases the photosyntheticefficiency [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 watercontent(Table 3).The highest relative leafwater content was recorded by T_3 (78.11%) followed by T_2 (75.62%) and T_1 (73.28%) whilethe lowest (69.69%) was by T_8at 60 DAS. Similarly, T_3recorded thehighest (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. Therelativeleafwatercontentisoneofthemaindeterminantsof thewater condition of the plant body. It maintains equilibrium between a plant's water intake and transpiration rate [18]. [17] opined that pruning can reduce vegetative growthand increase light penetration into the inner canopy, but it also raises the temperature, which results inwater loss. However, it was discovered from the current investigation that because of pruningon the main stem, T_3resulted 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 higherrelative leaf water content. The economic yieldwassubstantiallyimpactedbyrelativeleafwatercontent as reported by [19].

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). Maximumleaf 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 thepresent investigation. The highest leaf area index was recorded by treatment T_3at 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]. [21] and [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 underT_3might be the reason for increase in number of leaves per vine in the current investigation. As reported by [22] when leaf-fruit ratio is increased, it simultaneously results in highernumberoffruitsandmorecarbohydratecontent. 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 naturalstate they show uncontrolled growth and alsothere is decrease in yield [11].

Table 3. Effect of pruningon 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

3.3 Effect of pruningon yield per plant and per hectare

As depicted in Table 4,pruning had significantinfluence 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 [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 [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 [28] and in chilli by [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 8th node stage, T_2: trimming of growingtip of the primary vine at 10th node stage, T_3: trimming of growing tip of the primary vine at12thnodestage,T_4: trimmingof growingtipofthesecondaryvineat6thnodestage,T_5: trimming of growing tip of the secondary vine at 8th node stage, T_6: removal of all tertiaryvines,T_7: retentionoftwotertiaryvinesandT_8: controlwithoutpruning

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.

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