

**Original Research Paper**

## Advancing fruiting season in *Annona* cv. Arka Sahan through pruning

Chander S.<sup>S\*</sup>, Kurian R.M., Satisha J., Upreti K.K. and Laxman R.H.

ICAR-Indian Institute of Horticultural Research, Bengaluru - 560089, India

<sup>S</sup>Punjab Agricultural University, RRS, Abohar - 152116, India

\*Corresponding author Email : subhashghorela@pau.edu

### ABSTRACT

*Annona* cultivar 'Arka Sahan', an inter-specific hybrid of *Annona atemoya* × *A. squamosa* comes to harvest during August-September under mild tropical climate, which coincides with monsoon rains resulting in poor fruit quality and high susceptibility to anthracnose and fruit fly. An attempt was made to advance the fruiting in this hybrid through pruning during 2016-17 and 2017-18. The effect of three pruning levels (25, 50 and 75% of previous season's growth) at five different times (60, 75, 90, 105 and 120 days after final harvest of previous crop) on flowering and fruiting were compared. Early sprouting, flowering and fruit harvest were recorded in trees pruned to 75% of the past season's growth in both the years. Earliest fruits were harvested 271 (3<sup>rd</sup> week of June) and 268 (2<sup>nd</sup> week of June) days after pruning in trees pruned during first week of October in 2016-17 and 2017-18 respectively (P<0.05). Bigger fruits with lesser seeds per 100 g of pulp (P<0.05) were harvested from trees pruned to 75% and 25% levels in the first and second year, respectively, irrespective of pruning time. Tree canopy following pruning at 75% level recorded higher light interception and photosynthetic rate (P<0.05). Pruning time and levels significantly influenced the biochemical constituents of leaf and shoot. The fruiting in cultivar 'Arka Sahan' could be thus advanced by 8-9 weeks to June from the normal season of August-September with comparable or better fruit quality by pruning 75% of the last season's growth during October.

**Keywords:** Annona, biochemical constituents, fruit quality, off-season and pruning

### INTRODUCTION

Sugar apple (*Annona squamosa* L.), also known as sweet sop, sugar apple, sitaphal or sharifa and as custard apple in India is a native of tropical America and West Indies, introduced to India. The fruits are generally used fresh, while some products like custard powders and ice-creams are prepared from the fruits. 'Arka Sahan' is an inter-specific hybrid between *A. atemoya* (var. Island Gem) × *A. squamosa* (var. Mammoth). It is a vigorous plant. Its mature fruits take about 6-7 days to ripe. The creamy white colour flesh is juicy with mild pleasant aroma and tender with fewer seeds (9/100 g pulp) and large segments. The edible pulp is remarkable for its sweetness with 22.8 per cent total sugars and measures more than 30<sup>0</sup> B as against 24<sup>0</sup> B in Mammoth (Jalikap and Kumar 2007). Flowering in annona occurs on current season growth arising after natural leaf fall during late winter. In annona, flower bud formation is restricted to early

shoot development, and is extra-axillary, borne opposite to leaves (George and Nissen 1991). The leaf imposed para-dormancy of axillary bud is present in annona (George and Nissen 1987). Soler and Cuevas (2008) reported off-season (winter season) fruit production through shoot pruning followed by tipping the newly emerged shoots in cherimoya. Normal fruiting time of 'Arka Sahan' grown under the mild tropical climate is August-September, which coincides with monsoon rains resulting in deterioration of fruit quality due to anthracnose incidence and fruit fly infestation during the rainy period. Flowering can be manipulated by modifying the timing of bud break in annona species to get fruit out of season. For this leaf fall is prerequisite to open up the sub-petiolar axillary bud residing under the leaf petiole. We attempted to make the annona hybrid 'Arka Sahan' to flower and fruit early through pruning, which could induce early defoliation, bud sprouting and formation of new shoots and flowers and thus advance fruiting season to



summer months. The pruning techniques were standardized in terms of time and severity, keeping in view the flowering and fruiting behavior of the cultivar 'Arka Sahan'.

## MATERIALS AND METHODS

The experiment was conducted at ICAR - Indian Institute of Horticultural Research, Bengaluru (Karnataka state, India) during two consecutive years, 2016-17 and 2017-18. The experimental material consisted of eight-year-old one hundred and twenty uniform plants of *Annona* cv. Arka Sahan planted at a distance of 5m × 5m. The treatments comprised of five pruning times (T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> & T<sub>5</sub>) and three shoot pruning levels (L<sub>1</sub>, L<sub>2</sub>, & L<sub>3</sub>). Pruning was performed after 60, 75, 90, 105 or 120 days after final harvest of the previous crop. Pruning levels consisted of removal of 25 per cent (one-fourth of shoot length), 50 per cent (half of shoot length) or 75 per cent (two-third of shoot length) of the previous season's growth. Each treatment was replicated four times in a factorial randomized block design. Two trees were observed in each replication under each treatment for collection of data. Eight trees that were not pruned and giving new shoot growth naturally by the end of March following leaf abscission during late winter served as external check for comparison of treatment effects against natural fruiting as these could not be fitted effectively into the factorial design involving pruning time and intensity. Standard package of practices were adopted for maintenance of all the trees during the experimentation.

The number of days required for sprouting and flowering was assessed by recording the days taken for the emergence of first sprout and flower respectively after the treatment imposition. The durations of the first and last harvest were calculated from the date of imposing the treatments to the first fruit harvest and the last fruit harvest respectively. The total fruit yield per tree was recorded at harvest by measuring the weight of fruits harvested and values were expressed in kilogram. Fruit weight (g) was recorded using electronic balance. The total soluble solids (TSS) were measured using digital refractometer and expressed as degree Brix. Titrable acidity was estimated by adopting the *titrametric* method of A.O.A.C (1975) using phenolphthalein indicator and the values were expressed in terms of percentage citric acid equivalent. Pulp content (%) of fruit was determined using the following formula:

$$\text{Pulp (\%)} = \frac{\text{Pulp weight}}{\text{Fruit weight}} \times 100$$

The number of seeds per 100 g of pulp was calculated by using the following formula:

$$\text{Number of seeds per 100 g of pulp} = \frac{\text{Number of seeds in fruit}}{\text{Pulp weight of fruit}} \times 100$$

Gas exchange parameters such as net photosynthesis (P<sub>N</sub>, μmol m<sup>-2</sup> s<sup>-1</sup>), transpiration rate (E, mmolm<sup>-2</sup> s<sup>-1</sup>) and stomatal conductance (gs, mmol m<sup>-2</sup>s<sup>-1</sup>) were recorded in three fully expanded leaves of each plant using portable photosynthesis system (LCpro+, ADC BioScientific limited, UK) during morning hours of clear and sunny conditions between 09:30 h and 11:30 h at two stages *viz.*, fruit set (March, 2018) and rapid fruit growth (May, 2018) stage in the second year (2017-18) of study. Photosynthetically active radiation (PAR) below the tree canopy was measured using the LI-191SA Line Quantum Sensor (Li-Cor, Lincoln, NE) on uniformly overcast days between 12:00 h and 13:00 h at the fruit set and rapid fruit growth stages (FSS and RFGS) during 2017-18. The total leaf chlorophyll content was measured at FSS using spectrophotometer (UV 1650PC, Shimadzu, Japan) at wave lengths of 645 and 663 nm as per Hiscox and Isrealstam (1979). Total sugar in shoot was estimated after the harvest of fruits following the method of Somogyi, (1952).

Statistical analysis was done separately for the parameters studied for each year using OPSTAT (Sheoran *et al.*, 1998) and discussed at *P* < 0.05 for significance of difference between their mean values.

## RESULTS AND DISCUSSION

**Physiological and biochemical characteristics:** Pruning, especially its levels, significantly influenced the amount of light interception at both fruit set stage (FSS) in March and rapid fruit growth stage (RFGS) in May (*P*<0.05) (Table 2). Higher light interception in different treatments could be related to longer shoot length and higher number of leaves and leaf area in 75 per cent pruned trees (*P*<0.05). Differential light interception within tree canopies can also influence vegetative growth, flower initiation, fruit set, fruit size and fruit quality (Marini and Marini, 1983). Higher light interception was also associated with higher photosynthetic rate of leaves at both fruit set and rapid fruit growth stage. Pruning provided open canopy area and resulted in maximum interception of sunlight for

**Table 1 : Details of timing and level of pruning**

Treatment	Pruning level	Pruning time
T <sub>1</sub> L <sub>1</sub>	25% pruning	60 DAFH*
T <sub>1</sub> L <sub>2</sub>	50% pruning	(1 <sup>st</sup> week of October)
T <sub>1</sub> L <sub>3</sub>	75% pruning	
T <sub>2</sub> L <sub>1</sub>	25% pruning	75 DAFH
T <sub>2</sub> L <sub>2</sub>	50% pruning	(3 <sup>rd</sup> week of October)
T <sub>2</sub> L <sub>3</sub>	75% pruning	
T <sub>3</sub> L <sub>1</sub>	25% pruning	90 DAFH
T <sub>3</sub> L <sub>2</sub>	50% pruning	(1 <sup>st</sup> week of November)
T <sub>3</sub> L <sub>3</sub>	75% pruning	
T <sub>4</sub> L <sub>1</sub>	25% pruning	105 DAFH
T <sub>4</sub> L <sub>2</sub>	50% pruning	(3 <sup>rd</sup> week of November)
T <sub>4</sub> L <sub>3</sub>	75% pruning	
T <sub>5</sub> L <sub>1</sub>	25% pruning	120 DAFH
T <sub>5</sub> L <sub>2</sub>	50% pruning	(1 <sup>st</sup> week of December)
T <sub>5</sub> L <sub>3</sub>	75% pruning	

\*Days after final fruit harvest

higher rate of photosynthesis (Singh and Singh 2007). Similar results were recorded by Sharma *et al.* (2006) that the light interception was significantly influenced by pruning intensity in mango, being higher for pruned trees than for not pruned ones. The highest value of diffuse light availability below the canopy was recorded for severely pruned trees than for trees not pruned. Higher photosynthetic rate was recorded in trees pruned to 75 per cent level compared to 50 and 25 per cent levels ( $P < 0.05$ ) (Table 2). Higher photosynthetic rate reflects more metabolic activity in these leaves which could be attributed to interception of more light by the leaves. The trees pruned to 75 per cent produced longer shoots carrying more leaves, which harvested more light. Similar results were observed by Sharma *et al.* (2006) in mango where higher photosynthetic rate was recorded in leaves of pruned trees than trees not pruned. However, stomatal conductance was not affected much due to pruning in the present study (Data not presented). It ranged from 0.07 to 0.18 mmol m<sup>-2</sup> s<sup>-1</sup> among the treatments. The leaf chlorophyll content is considered as an important index of the metabolic activity of plants. At both FSS and RFGS, chlorophyll content exhibited differential pattern in response to different levels of pruning (Table 2). Accumulation of higher chlorophyll content in leaf could be related to the higher light interception which favoured the synthesis of more chlorophyll. Light interception by 75 per cent level pruned trees was higher at both fruit set and rapid growth stages. The lower chlorophyll content in the other treatments may

be attributed to limited chlorophyll synthesis for want of conducive environmental conditions (Sritharan *et al.*, 2010). Although, there was significant influence of pruning time and pruning levels on chlorophyll content at fruit set stage, no consistent results were evident over the years. At fruit set, the amount of chlorophyll content varied from 1.5 to 3.1 mg/g in the first year and from 1.2 mg to 3.2 mg/g in the second year. At rapid fruit growth stage, in the first year, pruning treatments did not influence the chlorophyll content while in the second year, significant influence was recorded with chlorophyll content varying from 2.0 to 2.8 mg/g ( $P < 0.05$ ). Sharma and Chauhan (2003) reported higher chlorophyll content in leaves of pruned peach tree leaves as compared to trees not pruned. However, total leaf chlorophyll content was recorded similar for both pruned and unpruned mango trees during April and July while during November it was recorded highest in pruned trees (Schaffer and Gaye 1989). Presence of higher amount of sugar in shoots of trees pruned at 25 per cent level in the present study, could be attributed to poor translocation of sugar for the growth of shoot or more towards the developing fruits which was also reflected in terms of relatively, smaller shoot and less number of leaves in 25 per cent pruned trees. However, sugar accumulation in shoot was recorded more in the second year (506.2 mg/100 g) over the first year (457.4 mg/100 g) which could be related to the favourable environmental condition prevailed including higher rainfall (average 2.41 mm per month), relative humidity (average 76.32%) and maximum temperature (average 29.74° C) in the second year (October to July) than the first year (rainfall 1.76 mm & relative humidity 68.47%). Shoots that emerged from 75 per cent pruning treatments were longer, which also reflected better translocation and utilization of sugar in the growth of shoot. Overall, total sugar content was affected by pruning levels, the results are in conformity with those of Bagchi *et al.* (2008) who observed that pruning up to 10 cm with complete removal of old leaves showed significant effect on increasing reducing sugars (36.7 mg/g) than other treatments and control.

**Growth and yield characteristics:** Pruning led to leaf fall followed by sprouting of sub petiolar axillary buds on the shoot. Irrespective of pruning time, the number of days required for sprouting has become shorter with the increase of pruning level during both the years with minimum number of days to sprout for those pruned in December first week and October first week in first and second years, respectively ( $P < 0.05$ ) (Table 3). Early sprouting in trees pruned to 75 per cent level

**Table 2 : Effect of pruning time and pruning levels on light interception, photosynthetic rate, total leaf chlorophyll and total sugar in *Annona* cv. Arka Sahan**

Treatment	Light interception (%)		Photosynthetic rate ( $\mu\text{mol m}^{-2} \text{s}^{-1}$ )	Total leaf chlorophyll (mg g <sup>-1</sup> )		Total sugar (mg/100 g)	
	FSS	RFGS		2016-17	2017-18	2016-17	2017-18
T <sub>1</sub> L <sub>1</sub>	21.8	65.1	7.9	3.1	3.2	399.3	480.0
T <sub>1</sub> L <sub>2</sub>	41.5	82.6	7.7	2.5	2.5	352.0	415.0
T <sub>1</sub> L <sub>3</sub>	58.8	92.0	10.8	2.9	3.1	181.5	249.3
T <sub>2</sub> L <sub>1</sub>	19.6	66.3	5.7	2.3	2.2	372.0	410.8
T <sub>2</sub> L <sub>2</sub>	40.6	75.9	5.8	2.9	3.0	427.8	504.0
T <sub>2</sub> L <sub>3</sub>	55.7	90.6	7.2	2.3	2.3	182.5	299.0
T <sub>3</sub> L <sub>1</sub>	24.4	71.9	4.5	2.3	2.4	467.5	531.0
T <sub>3</sub> L <sub>2</sub>	32.5	80.2	4.8	2.0	1.8	408.8	472.0
T <sub>3</sub> L <sub>3</sub>	59.4	85.2	8.7	2.2	2.1	278.8	327.8
T <sub>4</sub> L <sub>1</sub>	21.0	70.4	7.6	1.7	1.2	589.5	698.0
T <sub>4</sub> L <sub>2</sub>	47.4	76.9	8.0	1.5	2.9	570.5	573.0
T <sub>4</sub> L <sub>3</sub>	58.4	84.1	8.7	2.0	3.1	326.5	539.0
T <sub>5</sub> L <sub>1</sub>	24.6	73.4	6.8	1.8	2.6	458.8	411.0
T <sub>5</sub> L <sub>2</sub>	40.6	80.5	6.4	1.6	2.5	427.0	498.0
T <sub>5</sub> L <sub>3</sub>	58.7	92.7	7.5	1.9	1.8	364.0	431.0
External Check	20.3	60.2	7.6	3.0	3.1	350	465
T <sub>C.D.</sub> (P=0.05)	-	3.00	1.11	0.03	0.04	6.71	8.39
L <sub>C.D.</sub> (P=0.05)	2.81	2.33	0.86	0.03	0.03	5.20	6.50
T x L <sub>C.D.</sub> (P=0.05)	6.28	5.20	1.92	0.06	0.07	11.62	14.53

T: Time of pruning; L: Level of pruning; FSS : Fruit Sel Style; RFGS : Rapid Fruit Growth Style

**Table 3 : Effect of pruning time and levels on sprouting, flower initiation, fruit yield and its pattern of *Annona cv. Arka Sahana***

Treatment	Sprouting (days)		Flower initiation (days)		First harvest (days)		Final harvest (days)		Fruit yield per tree (kg)		Fruit yield per TCSA (kg/cm <sup>2</sup> )	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T <sub>1</sub> L <sub>1</sub>	85.3	104.7	100.6	132.8	297.5	307.5	307.5	320.0	12.0	20.2	0.10	0.14
T <sub>1</sub> L <sub>2</sub>	57.5	60.7	75.7	74.5	285.0	279.5	302.0	306.3	10.1	14.9	0.07	0.09
T <sub>1</sub> L <sub>3</sub>	23.3	13.7	42.9	26.3	271.0	268.9	299.5	302.5	11.1	16.1	0.09	0.11
T <sub>2</sub> L <sub>1</sub>	60.5	104.6	77.7	126.1	290.0	291.0	305.0	301.8	10.2	17.7	0.08	0.13
T <sub>2</sub> L <sub>2</sub>	28.0	90.1	45.4	105.3	277.5	266.0	296.3	295.0	11.2	15.7	0.09	0.10
T <sub>2</sub> L <sub>3</sub>	17.5	20.0	35.3	33.9	271.0	245.0	287.0	295.0	11.3	17.0	0.08	0.10
T <sub>3</sub> L <sub>1</sub>	41.6	44.9	54.2	54.8	269.0	276.8	279.0	285.5	9.0	18.9	0.08	0.14
T <sub>3</sub> L <sub>2</sub>	25.5	32.6	42.9	55.6	269.8	265.8	278.0	284.5	10.0	19.4	0.09	0.14
T <sub>3</sub> L <sub>3</sub>	16.3	17.6	48.2	42.2	271.3	235.0	287.3	281.0	10.1	16.8	0.09	0.11
T <sub>4</sub> L <sub>1</sub>	31.5	62.9	44.4	76.1	269.0	261.5	284.0	266.8	8.7	20.5	0.07	0.13
T <sub>4</sub> L <sub>2</sub>	19.2	39.6	33.8	55.7	270.8	252.5	284.0	276.0	9.3	16.4	0.07	0.10
T <sub>4</sub> L <sub>3</sub>	16.2	18.4	56.8	44.0	276.3	236.8	285.0	271.5	10.8	15.2	0.08	0.10
T <sub>5</sub> L <sub>1</sub>	25.2	45.1	38.5	59.8	270.0	246.8	283.0	258.3	9.8	20.6	0.07	0.12
T <sub>5</sub> L <sub>2</sub>	20.9	33.5	37.8	45.6	271.0	236.5	283.0	255.0	10.5	19.1	0.07	0.12
T <sub>5</sub> L <sub>3</sub>	14.7	17.3	50.8	40.6	274.5	222.5	283.0	244.8	11.3	16.4	0.08	0.09
External Check	118	135	133	145	321	329	335	338	14.2	20.1	0.09	0.14
T <sub>C.D.</sub> (P=0.05)	3.06	5.10	4.39	5.07	3.98	2.55	3.25	4.78	0.21	1.27	0.01	0.01
L <sub>C.D.</sub> (P=0.05)	2.37	3.95	3.40	3.93	3.08	1.98	2.52	3.70	0.16	0.98	-	0.01
T x L <sub>C.D.</sub> (P=0.05)	5.29	8.84	7.61	8.78	6.89	4.42	5.64	8.28	0.36	2.20	-	-

T: Time of pruning; L: Level of pruning;

could be attributed to very few leaves or no leaf left on such shoots and with less number of buds available on the shoot, the reserve metabolites from trunk could have contributed to early release of these buds. Similar results were observed in cherimoya (Soler and Cuevas, 2008) and guava (Shaban and Haseeb, 2009), where severely pruned trees gave early sprouting. Also, early flowering occurred in trees pruned to 75 per cent level ( $P < 0.05$ ). In a less vigorous cultivar of sugar apple, Balanagar, early shoot growth during winter could be induced under similar climatic condition through chemical defoliation (Chander *et al.*, 2019). Since flowering is on current season growth in *Annona* and concomitant with the shoot growth, early sprouting resulted in early flowering in both the years. However, in the first year, flowering was earlier on trees pruned to 50 per cent level during November and December despite early sprouting in those pruned to 75 per cent level. It was observed that there was continuous vegetative growth in 75 per cent pruned trees. Similar results were reported in custard apple (George and Nissen, 1987), cherimoya (Soler and Cuevas, 2008) and atemoya (Olesen and Muldoon, 2012). Pruning treatments significantly influenced the flowering and fruiting period of *Annona* cv. 'Arka Sahan' (Table 3). Earliest fruits were harvested from the treatments imposed in 1<sup>st</sup> week of October, at 75 per cent pruning level ( $T_1L_3$ ) with minimum days (271) to harvest by 2<sup>nd</sup> week of June in first year ( $P < 0.05$ ). A consistent result was recorded for early harvest (2<sup>nd</sup> week of June) with 75 per cent pruned trees in second year for all pruning time. Early harvest from 75 per cent pruned trees could be attributed to advanced flowering and fruit set in these trees. Observations recorded on final harvest exhibited significant differences with pruning time and pruning level (Table 3). In both the years, the final harvest extended longer for the 25 per cent pruned trees ( $P < 0.05$ ). Final harvest in case of 75 per cent pruning was completed earlier than 25 per cent or 50 per cent pruning. Early harvest in these trees could be attributed to earlier induction of flowering and pollination than the other treatments. The results are in conformity with those reported by Vinay *et al.* (2014) in custard apple and Adhikari and Kandel (2015) in guava. Higher yield was obtained from trees pruned during 1<sup>st</sup> week of October at 25 per cent level ( $T_1L_1$ ) while for rest of the pruning treatments greater yield was recorded from 75 per cent pruned trees in the first year. However, in the second year, maximum yield per tree was obtained from 25 per cent pruned trees (Table 3). Higher yield in respective years could be attributed to bearing of larger size of fruits and occurrence of prevailing congenial environmental

conditions during the fruit growth. Also, accumulation of more sugars in the shoot of 25 per cent pruned trees at harvest reflect more availability of assimilates to fruits on these trees. Fruits were harvested near to normal season from trees pruned to 25 per cent level which could have advantage of prevailing congenial environmental condition than other treatments. The results are in conformity with Kumar *et al.* (2010) in peaches and Choudhary and Dhakare (2018) in sugar apple, where heavy pruning (90 cm) gave lesser yield than light or trees not pruned but medium pruning (30-45 cm) recorded higher yield per tree. The yield per TCSA was not influenced much with pruning treatments, which could be attributed to lesser effect of pruning treatments on trunk growth (Table 3). In the second year, comparatively higher yield per tree was recorded although there was not much improvement in trunk growth. Higher yield in second year could be more related to the increase of yield per tree rather than trunk circumference.

**Fruit quality characteristics:** There was consistent significant effect of pruning levels on fruit weight and pulp content in both the years ( $P < 0.05$ ) (Table 4). Higher fruit weight and pulp content in 75 per cent pruned trees could be attributed to the better growth of shoot with higher number of leaves which resulted in higher synthesis of photosynthates in these shoots. The higher amount of accumulated photosynthates could have contributed for bigger size of fruits. Similar results were reported in custard apple (Olesen and Muldoon, 2009; Choudhary and Dhakare, 2018) and ber (Gupta and Gill, 2015). However, in the second year, trees pruned at 25 per cent level recorded the maximum fruit weight and pulp content which could be due to availability of sufficient stored carbohydrates, confirmed with the estimation of higher sugar in the developed shoot. Similar trend was observed on other fruit quality parameters including fruit volume, fruit length, fruit width and fruit circumference with the pruning treatments imposed over two years (data not presented). Results indicated that irrespective of pruning time, comparatively fewer seeds per 100 g of pulp were recorded in 75 per cent and 25 per cent pruning levels in the first and second years, respectively ( $P < 0.05$ ). As the fruit size including fruit weight, volume, and pulp content was recorded more in these treatments this could have lowered the proportion of seed per unit of pulp. Similar findings were also observed by Chander and Kurian (2019) in sugar apple and Teatota and Singh (1971) in guava where lesser percentage of seed was recorded in heavier fruit obtained from pruned trees. Pruning

**Table 4 : Effect of pruning time and pruning levels on fruit quality attributes of *Annona* cv. Arka Sahana**

Treatment	Fruit weight (g)		Pulp content (%)		Seeds per 100 g of Pulp		TSS (°B)	
	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18	2016-17	2017-18
T <sub>1</sub> L <sub>1</sub>	248.1	432.9	59.9	80.1	29.1	12.4	36.3	33.9
T <sub>1</sub> L <sub>2</sub>	301.5	350.8	69.5	70.5	22.7	15.4	35.2	32.0
T <sub>1</sub> L <sub>3</sub>	316.5	363.6	64.2	76.2	21.9	16.1	34.5	31.8
T <sub>2</sub> L <sub>1</sub>	257.9	394.0	63.6	80.3	24.1	12.1	37.0	33.6
T <sub>2</sub> L <sub>2</sub>	265.6	361.5	66.3	75.2	25.6	15.2	35.4	33.0
T <sub>2</sub> L <sub>3</sub>	310.7	421.4	67.7	73.3	20.3	15.0	32.8	31.8
T <sub>3</sub> L <sub>1</sub>	278.9	468.7	65.8	79.0	27.1	12.4	35.5	33.8
T <sub>3</sub> L <sub>2</sub>	308.9	452.8	66.8	78.6	24.2	15.4	36.7	32.8
T <sub>3</sub> L <sub>3</sub>	289.7	394.5	68.2	66.2	22.2	18.2	35.0	31.3
T <sub>4</sub> L <sub>1</sub>	262.5	456.0	66.5	80.0	26.1	13.5	36.3	32.6
T <sub>4</sub> L <sub>2</sub>	250.8	402.7	68.5	77.4	24.2	13.4	36.1	32.4
T <sub>4</sub> L <sub>3</sub>	275.0	385.8	70.8	74.3	19.2	15.5	35.3	31.7
T <sub>5</sub> L <sub>1</sub>	262.9	451.2	62.3	79.1	25.7	13.5	36.0	33.5
T <sub>5</sub> L <sub>2</sub>	273.1	408.7	65.8	69.7	28.6	13.1	35.7	32.9
T <sub>5</sub> L <sub>3</sub>	278.7	441.4	66.6	73.9	23.9	16.1	35.9	32.2
External Check	300	375	61.4	66.1	23.2	15.8	31.8	30.2
T <sub>C.D.</sub> (P=0.05)	-	36.73	2.72	-	-	-	0.60	-
L <sub>C.D.</sub> (P=0.05)	18.23	28.45	2.11	2.34	2.62	1.39	0.47	0.54
T x L <sub>C.D.</sub> (P=0.05)	-	-	-	5.22	-	-	1.04	-

T: Time of pruning; L: Level of pruning

influences quality of the fruits by regulating carbohydrate allocation to the developing fruits (Palanichamy *et al.*, 2011). Early pruning during October-November resulted in increased level of total soluble solids (TSS) of the fruit than the later or trees not pruned ( $P < 0.05$ ) (Table 4). The prevailing congenial temperature during fruit growth and maturation could have contributed for accumulation of more sugar in the developing fruits as the fruits come to harvest earlier in these pruned trees. In both the years, comparatively higher value of prevailing average maximum temperature (31.11, 31.50°C) was recorded from flowering to fruit maturity (February to June) for October-November pruned trees than the late pruned trees wherein lesser average maximum temperature (30.73, 30.33°C) was recorded from flowering to fruit maturity (April to August). The results are in conformity with those of Kadam *et al.* (2018) in custard apple cv. Dharur-6 where fruits from light pruned (20 cm) trees recorded maximum TSS content. In contrast, heavy pruning resulted in accumulation of more TSS in grapes (Zabadal *et al.*, 2002) and peach (Chitkara *et al.*, 1991). There were no consistent trends of acidity content of fruit pulp although higher level of acidity was observed in trees pruned to 75 per cent level (data not presented). Chitkara *et al.* (1991) and Kumar *et al.* (2010) recorded increased acidity level with the increase of pruning severity in peaches. Similar results were obtained by Mehta *et al.* (2012) in guava and Kadam *et al.* (2018) in custard apple cv. Dharur-6.

### CONCLUSION

Induction of off-season crop with better quality is a new technique in sugar apple production that could enable the growers to get better market and profitability. Fruiting could be advanced by 8-9 weeks to June with pruning at 75 per cent level during October in *Annona* cv. Arka Sahan from the normal fruiting season of August - September.

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