

**STUDIES ON THE EFFECT OF PRUNING INTENSITIES AND TIME
ON WINTER GUAVA PRODUCTION IN CV. ALLAHABAD SAFEDA
UNDER HIGH DENSITY PLANTING**

Thesis

by

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(NH-2019-16-M)**

Submitted to



**Dr. YASHWANT SINGH PARMAR UNIVERSITY OF
HORTICULTURE AND FORESTRY, NAUNI,
SOLAN (HP) – 173 230 INDIA**

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**MASTER OF SCIENCE
(HORTICULTURE)
FRUIT SCIENCE
DEPARTMENT OF FRUIT SCIENCE
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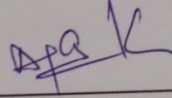
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CERTIFICATE -I

This is to certify that the thesis entitled, "Studies on the effect of pruning intensities and time on winter guava production in cv. Allahabad Safeda under high density planting" submitted in partial fulfillment of the requirements for the award of degree of **MASTER OF SCIENCE (HORTICULTURE) FRUIT SCIENCE** to Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauli, Solan (HP) is a record of bonafide research work carried out by **Ms. Shivani Pathania (NH-2019-16-M)** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of investigations have been fully acknowledged.

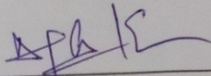


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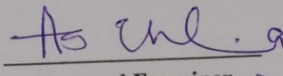
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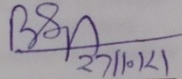
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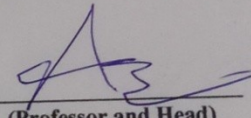
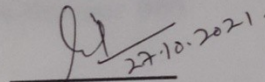
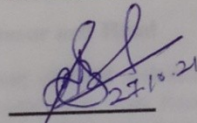
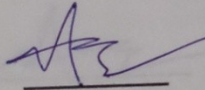
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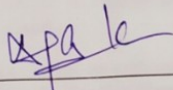


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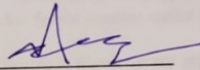
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This is to certify that all the mistakes and errors as pointed out by the external examiner have been incorporated in the thesis titled, "**Studies on the effect of pruning intensities and time on winter guava production in cv. Allahabad Safeda under high density planting**", submitted by Ms. Shivani Pathania (NH-2019-16-M) Daughter of Sh. Desh Raj to Dr. Yashwant Singh Parmar University of Horticulture and Forestry, (Nauni) Solan (H.P.)- 173230 in the partial fulfilment for the award of degree of **MASTER OF SCIENCE (HORTICULTURE) FRUIT SCIENCE**.



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Place: Hamirpur

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CONTENTS

Chapter	Title	Page (s)
1	INTRODUCTION	1-3
2	REVIEW OF LITERATURE	4-27
3	MATERIALS AND METHODS	28-35
4	RESULTS AND DISCUSSION	36-62
5	SUMMARY AND CONCLUSION	63-65
	LITERATURE CITED	66-75
	APPENDICES	i-ix
	ABSTRACT	76
	BRIEF BIO DATA OF STUDENT	

ABBREVIATIONS

%	Per cent
π	Pi
/	Per
>	Greater than
°C	Degree centigrade
ANOVA	Analysis of variance
AOAC	Association of Official Agriculture Chemist
cc	Cubic centimeter
CD	Critical difference
cm	Centimeter
cm ²	Square centimeter
cv.	Cultivar
df	Degree of freedom
<i>et al.</i>	Co-workers
g	Gram
H P	Himachal Pradesh
ha	Hectare
HCl	Hydrochloric acid
<i>i.e.,</i>	That is
kg	Kilogram
m	Meter
mg	Milli gram
ml	Milliliters
mg/ 100 g	Milligram per 100 gram
mm	Milli meter
MT	Metric Ton
NaOH	Sodium Hydroxide
NS	Non-significant
°B	Degree brix
RBD	Randomized Block Design
TCSA	Trunk cross sectional area
TSS	Total Soluble Solids
<i>Viz.,</i>	<i>Videlicet</i>
w.r.t.	With respect to

LIST OF TABLES

TABLE No.	TITLE	PAGE(S)
3.1	Details of treatment of experiment.	29
4.1	Effect of pruning intensity and time of pruning on plant height and leaf area of guava.	37
4.2	Effect of pruning intensity and time of pruning on plant canopy spread in E-W and N-S of guava.	39
4.3	Effect of pruning intensity and time of pruning on shoot length and shoot diameter of guava.	42
4.4	Effect of pruning intensity and time of pruning on trunk girth of guava.	43
4.5	Effect of pruning intensity and time of pruning on canopy volume and TCSA of guava.	44
4.6	Effect of pruning intensity and time of pruning on days for flower emergence and number of flowers per shoot of guava.	46
4.7	Effect of pruning intensity and time of pruning on fruit set and fruit yield of guava.	49
4.8	Effect of pruning intensity and time of pruning on fruit weight and fruit volume of guava.	51
4.9	Effect of pruning intensity and time of pruning on fruit length and fruit width of guava.	53
4.10	Effect of pruning intensity and time of pruning on TSS and titratable acidity of guava.	56
4.11	Effect of pruning intensity and time of pruning on TSS/ acid ratio and ascorbic acid of guava.	58
4.12	Effect of pruning intensity and time of pruning on reducing sugars and total sugars of guava.	60
4.13	Effect of pruning intensity and time of pruning on non-reducing of guava.	61

LIST OF PLATES

PLATE	TITLE	BETWEEN THE PAGE (S)
1	An overview of the experimental site.	29-30
2	Plants pruned at different pruning intensities.	31-32
3	Different phonological stages in guava.	47-48
4	Fruit production under different pruning intensities.	49-50
5	Fruit quality under different pruning treatments.	53-54

Chapter-1

INTRODUCTION

Guava (*Psidium guajava* L.), the apple of tropics, is one of the most promising evergreen fruit belonging to the family myrtaceae. The family comprises of about 150 genera and more than 3000 species, out of which *Psidium guajava* is commercially exploited. Guava is considered as one of the most exquisite, nutritionally rich and remunerative fruit crops (Singh, 2007). It is native to tropical America extending from Mexico to Peru. The crop is extensively cultivated in the tropical and subtropical regions of the world due to its wider adaptability.

Guava has gained considerable prominence among the growers and the consumers due to its high nutritive value and availability at reasonable prices. The fruit is loaded with nutrients and exceedingly rich in vitamin C (305 mg/100 g), pectin (0.5-1.8 %), dietary fibers and antioxidants. The fruit ranks 3rd in vitamin C content after Barbados cherry (1000-4000 mg/100g) and aonla (600 mg/ 100g of pulp) (Gupta, 2014). Besides this, it is also a good source of vitamin A, calcium, phosphorus and iron. On account of its unique flavour and dominant aroma, guava not only consumed as raw but also widely used in preparing several other processed products. The fruits are extensively used for preparing candies, preserves, jellies, jams, marmalades and juices.

Guava excels many other fruit crops in terms of productivity and adaptability. The demand for guava is ever rising in the domestic as well as international market. At present major guava producing countries are India, China, Thailand, Pakistan, Mexico, Indonesia, Brazil and Bangladesh. Guava is successfully grown all over India and its production in the country is gaining momentum day by day. Guava ranks fourth most vital fruit crop in area and production grown after mango, banana and citrus. At present in India, it is cultivated on an area of 2,92,000 ha with the production of 43,61,000 MT (Anonymous, 2020). Major guava producing states in India are Bihar, Uttar Pradesh, Maharashtra, Karnataka, Orissa, West Bengal, Andhra Pradesh and Tamil Nadu. In Himachal Pradesh, guava is cultivated on an area of

2,447 ha with annual production of 2,876 MT and productivity of 1.17 MT/ha (Anonymous, 2020).

Guava tree is hardy in nature and has prolific fruit bearing capacity. Guava cultivation has been extended to varying agro-climatic regions owing to its wider adaptability. Guava has been efficiently grown up to an altitude of 1500 m above mean sea level and thrives well in both humid and dry climates. Guava has enjoyed most climatic conditions across the globe with a little tolerance to the brief periods of cold spell except for harsh and hot air during flowering and fruiting stages.

Under subtropical conditions, guava bear fruits almost throughout the year. In North India, it exhibits two distinct flowering seasons in a year, first in April-May known as Ambe Bahar, the fruits of which are harvested during rainy season and secondly flowers in July- August known as Mrig Bahar, the fruits of which are harvested during winter season (Singh, 2007). In the southern parts of the country third flowering is observed during October known as Hasta Bahar, the fruits of which are obtained in spring season. In North India, Mrig Bahar is preferred over Ambe Bahar. Ambe Bahar produces heavy crop but the fruits harvested during the rainy season are of poor quality due to high water content, less nutritive, severely infested with fruit fly maggots while the winter harvested fruits are of superior quality, free from insect- pests and fetches good prices in the market (Prakash *et al.*, 2012).

Guava is amenable to pruning and light annual pruning influence the vigor, productivity and quality of the fruits (Gadgil and Gadgil, 1933). Besides giving structural strength, pruning also has a dwarfing influence on plants and thereby provides an opportunity to adopt closer planting system. Pruning has emerged as a cheap and effective technique to alter the cropping pattern, improve fruit yield and fruit quality of guava (Bhagwati *et al.*, 2015). Excessive vegetative growth in high density planting results in overcrowding of branches and insufficient light interception which subsequently leads to reduced flower buds formation and decreased fruit yield. Pruning is considered as a beneficial technique to replace the old, unproductive shoots with the new productive ones. Pruning is known to have direct or indirect effect on plant physiological processes coupled with some biochemical alterations within the

plants which further aids in restoring a balance between vegetative and reproductive growth of the plants.

In guava, the flowers and fruits are borne on current season's growth hence, a mild annual summer pruning reduces the flower bearing area in rainy season and induces new shoot growth which in turn increases flowering and fruiting of winter season crop. Plant vegetative growth, yield and fruit quality are directly proportional to the amount of light intercepted by the plants. Pruning promotes the rate of photosynthesis by inducing better light distribution within a tree canopy and subsequently enhances the proper water and nutrient supply within the reduced canopy leading to better quality fruits and higher returns.

Pruning severity and time of pruning, alters the nutritive conditions within the plants and also helps in the diversion of reserve food to the newly emerged shoots. Unpruned guava trees turns out to be unproductive after few years of growth. The prolonged vegetative growth in unpruned guava trees hampers sunlight to reach to the interior portion of the plants which eventually causes excessive shading and makes the inner portion of the plant unproductive and completely devoid of fruits. Pruning eliminates the crowded and criss-cross branches, reduces the chances of insect-pest incidence and increases fruit yield and improves fruit quality. Keeping the importance of time of pruning and pruning severities in mind, the present study was conducted with the following objectives:

- To study the effect of pruning intensity and time on vegetative and reproductive growth characteristics of guava.
- To study the effect of pruning intensity and time on yield and quality parameters of guava.

Chapter-2

REVIEW OF LITERATURE

Pruning is considered as an essential horticultural operation to maintain vigour and productivity of a crop. Pruning is a pre- requisite and a basic tool used to maintain proper tree architecture of fruit trees. A light annual pruning in guava is considered beneficial as it helps in inducing new shoots after the harvest, improves light distribution and reduces the chances of insect-pest or disease incidence within the tree canopy (Jadhav *et al.*, 2002). Pruning helps in the shifting the food material to the newly emerged shoots, increases the photosynthetic activity and thereby increase carbohydrate and starch accumulation. Pruning executed during summer season suppresses the summer flowering and reduces the production and yield of poor rainy season crop and subsequently increases the production of superior winter season crop. A brief information pertaining to the effect of pruning intensities and time of pruning on vegetative growth, reproductive and qualitative parameters are summarized hereunder the following heads and sub- heads:

2.1 Effect of pruning intensity and time of pruning

2.1.1 Vegetative growth characteristics

2.1.1.1 Tree height

Kumar and Rattanpal (2010) studied the effect of different pruning intensities *viz.*, removal of 1/2, 1/3rd and 1/4th vegetative current season growth in the month of April along with unpruned plants (control) on vegetative growth parameters of guava cv. Sardar. From their results, they revealed that pruning had a significant effect on plant height. Plant height was decreased with the increase in pruning intensity and was found maximum (5.6 m) in unpruned plants (control) while, minimum plant height (4.7 m) in plants which were pruned to ½ of their vegetative growth.

Mahesh *et al.* (2016) conducted an experiment to evaluate the effect of time of pruning and pruning intensities on growth and yield of guava cv. Sardar. They performed different pruning *viz.*, removal of 25, 50 and 75 per cent of length of shoot at different time's *viz.*, first week of April, third week of April and first week of May. They found maximum plant height which were pruned to 25 per cent in the third week

of April (1.65 m) followed by the plants pruned to 25 per cent during first week of May (1.60 m) whereas, minimum plant height (1.43 m) was observed in severely pruned plants (75 %) during first week of May.

Kumar *et al.* (2017) conducted an experiment to study the influence of pruning intensities *i.e.*, removal of 20, 40, 60 and 80 per cent of current season's shoot growth carried out twice during 15th February and 15th April along with control on vegetative growth characteristics of guava cv. Pant Prabhat. From their study, they concluded that the severest pruning intensity (80 %) exhibited maximum increase in tree height (21.38 cm) whereas, unpruned plants (control) recorded minimum increase in tree height (14.71 cm). Devarkonda *et al.* (2019) carried out an investigation to ascertain the influence of pruning intensities performed in the month of December *i.e.*, retaining one leaf pair, retaining of 25 per cent, 50 per cent, 75 per cent shoot, terminal leaf pair shoot pruning, removal of all leaves and flower buds by hand and control (no pruning) on growth and yield attributes of guava cv. Thai guava. They observed that unpruned plants (control) obtained maximum plant height (158.30 cm) followed by plants subjected to removal of terminal leaf pair (152.54 cm).

Harshitha *et al.* (2019) evaluated the influence of two pruning intensities *i.e.*, 75 and 100 cm on vegetative growth characteristics of 15 years old plants of guava cv. L-49. They observed that the plants subjected to 75 cm pruning produced maximum plant height (2.98 m). Kumar *et al.* (2020) assessed the influence of different pruning intensities *i.e.*, removal of 10, 20, 30, 40, 50 and 60 cm of plant shoots in the first week of September along with control (unpruned) on growth, yield and quality parameters of guava cv. Lalit. They obtained maximum plant height (413.66 cm) in plants which were pruned to 30 cm from the shoot tip followed by 20 cm (402.90 cm) while, unpruned plants (control) resulted in minimum plant height (344.20 cm). Lian *et al.* (2019) examined the response of different pruning intensities *viz.*, 25, 50 and 75 per cent of shoot length from the tip, performed at different times *i.e.*, mid-April, mid- May and mid- June on the growth and yield parameters of guava cv. L-49. From their results, they opined that the plants subjected to 25 per cent pruning intensity during mid- May resulted in maximum increase in plant height (59.00 cm) followed by the plants pruned to 25 per cent during mid- April (57.00 cm) while, the

minimum increase in plant height was observed in plants pruned to 75 per cent of shoot length from tip during mid- May (37.33 cm).

Pandey *et al.* (2020) executed different pruning intensities *viz.*, 20, 30 and 50 per cent along with control during mid- February and mid- May on six-year-old guava cv. Shweta. The results showed that pruning time and intensity had a significant effect on tree height. Maximum tree height (3.53 m) was observed in plants which were subjected to 50 per cent pruning intensity during mid- May followed by 30 per cent pruning intensity done in mid- May. However, the minimum plant height (2.20 m) was recorded in unpruned plants (control).

2.1.1.2 Canopy volume

Kumar and Rattanpal (2010) tried different pruning intensities *viz.*, removal of 1/2, 1/3rd and 1/4th vegetative current season growth during April along with unpruned plants (control) on vegetative growth characteristics of Sardar guava. They reported that pruning intensity has an inverse relation with plant canopy volume. They recorded maximum plant canopy volume in unpruned plants (118.80 m³) while, minimum plant canopy volume (57.70 m³) was observed in plants pruned to 1/2 of their vegetative growth.

Pilania *et al.* (2010) examined the effect of different pruning intensities *viz.*, removal of 25, 50 and 75 per cent of previous season growth in the month of February along with unpruned (control) on guava cv. Lalit. They obtained maximum canopy volume (0.60 m³) in the plant which was pruned to 50 per cent intensity followed by unpruned plants (0.59 m³) whereas, minimum plant canopy volume (0.24 m³) was produced in severely pruned plants. Purnima J. (2016) laid out an experiment to ascertain the effect of pruning intensity and time on growth and yield parameters of guava cv. Sardar. The plants were subjected to three pruning intensities *i.e.*, removal of 10, 15 and 20 cm length of shoot growth along with control performed during *viz.*, 3rd week (August – December) and 2nd week (September – January). It is inferred from the study that the maximum canopy volume (8.55 m³) was found in unpruned plants (control) while, minimum canopy volume (4.23 m³) was observed in plants subjected to 20 cm pruning intensity performed in 3rd week (August- December).

Kumar *et al.* (2017) assessed the effect of pruning intensities *i.e.*, removal of 20, 40, 60 and 80 per cent of current season's shoot growth performed twice during 15th February and 15th April along with control on vegetative and growth attributes of guava cv. Pant Prabhat. They obtained maximum increase in canopy volume (15.33 cm³) in plants which were subjected to 80 per cent pruning of current season's shoot growth followed by 60 per cent pruning intensity (13.79 cm³) while, minimum canopy volume (9.92 cm³) was exhibited by unpruned plants.

Sah *et al.* (2018) studied the effect of time of pruning on vegetative growth characteristics of guava cv. Pant Prabhat. They performed half shoot pruning in April, July, October, April- July, April- October, July- October, April- July- October along with unpruned plants (control). They obtained maximum plant canopy volume in plants pruned twice during July- October (9.92 m³) followed by plants pruned during April- October (9.41 m³). Dahupute *et al.* (2020) evaluated the effect of different pruning severities and time on vegetative growth characteristics of custard apple. They performed pruning intensities *viz.*, 15, 30 and 45 cm removal of main shoots along with secondary and tertiary shoots on three different dates *i.e.*, 15th April, 30th April and 15th May along with unpruned plants (control). Their findings revealed that plants pruned to 30 cm on 30th April resulted in maximum plant canopy volume (19.49 m³) followed by 15 cm pruning severity done on 30th May (18.63 m³) whereas, the minimum plant canopy volume (14.25 m³) was exhibited by unpruned plants.

Khokhar (2018) assessed the effect of different pruning intensities *i.e.*, removal of 20, 30 and 40 cm of vegetative growth at two different times *viz.*, 2nd fortnight of May and 1st fortnight of June along with control plants (unpruned) on guava cv. Sardar. He concluded that plant canopy volume was decreased with the increase in pruning severity, and was found maximum (107.30 m³) in unpruned plants (control) followed by plants subjected to 20 cm removal of vegetative growth during 2nd fortnight of May (59.42 m³) while, severely pruned plants during 1st fortnight of June resulted in minimum plant canopy volume (15.30 m³).

2.1.1.2 Leaf area

Kumari (2001) studied the effect of different pruning dates on vegetative characteristics of guava cv. Allahabad Safeda. The plants were subjected to light

pruning (removal of branches upto 20 cm) on different dates *viz.*, 17th May, 2nd June, 17th June and 5th July and reported highest leaf area in plants pruned on 17th June (72.72 cm²) followed by plants pruned on 2nd June (68.28 cm²) whereas, the minimum leaf area (60 cm²) was obtained in plants pruned on 5th July.

Koli *et al.* (2014) conducted an experiment on Nagpur mandarin to assess the effect of different pruning levels on rejuvenation of old orchard. The plants were subjected to varied pruning intensities *viz.*, pruning from 120, 150, 180 and 250 cm above the ground level along with unpruned plants (control) and found significant results w.r.t leaf area with the increase in pruning intensity. Maximum leaf area (24.33 cm²) was reported in plants which were pruned at 180 cm height from ground level while, minimum leaf area (12.53 cm²) was observed in unpruned plants. Pilonia *et al.* (2010) assessed the effect of different pruning intensities *viz.*, removal of 25, 50 and 75 per cent of previous season's growth on vegetative growth parameters of guava cv. Lalit. They recorded maximum leaf area (67.82 cm²) in plants which were pruned at 50 per cent pruning intensity followed by 75 per cent pruned plants (53.43 cm²) whereas, minimum leaf area (48.46 cm²) was recorded in unpruned plants.

Adhikari and Kandel (2015) investigated the effect of pruning intensities *viz.*, removal of 10, 20 and 30 cm of growth on one-year shoot from the tips at different times *i.e.*, mid- April, early- May and mid- May along with control on vegetative growth of guava cv. L-49. Their observations revealed that leaf area showed significant effect with the increase in the pruning intensities. Maximum leaf area (58.34 cm²) was obtained in plants pruned to 30 cm during early- May (71.73 cm²) followed by plants subjected to 30 cm pruning during mid- May (61.61 cm²) while, minimum leaf area (48.48 cm²) was observed in unpruned plants during mid- April. Bhuva *et al.* (2018) reported an increase in leaf area with the increase in pruning severity and crop load in pomegranate cv. Bhagwa. They performed pruning at different levels *viz.*, 15 cm pruning + 30 fruit retained per plant, 15 cm pruning + 40 fruit retained per plant, 15 cm pruning + 50 fruit retained per plant, 30 cm pruning + 30 fruit retained per plant, 30 cm pruning + 40 fruit retained per plant, 30 cm pruning + 50 fruit retained per plant and unpruned plants (control) and recorded maximum leaf area (10.50 cm²) in case of plants pruned to 30 cm with 50 fruits/ tree.

Supanjani *et al.* (2019) executed different pruning intensities to study its effect on growth attributes of guava cv. Crystal. The plants were subjected to different pruning intensities *viz.*, retaining 10, 20, 30 and 40 cm of shoot from the base along with control. Their observations revealed that unpruned plants (control) induced maximum leaf area (25.71 cm²) followed by plants retaining 40 cm of shoot (20.37 cm²).

2.1.1.3 Plant spread

Kumar and Rattanpal (2010) evaluated the effect of different pruning intensities *i.e.*, removal of $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$ current season growth in the month of April along with unpruned plants (control) on vegetative growth parameters of Sardar guava. They reported significant a decrease in plant spread with the increase in pruning intensity. They found maximum tree spread (6.50 m) in unpruned plants whereas, minimum tree spread (5.20 m) was observed in plants pruned to $\frac{1}{2}$ of their vegetative growth. Mahesh *et al.* (2016) performed different pruning intensities *viz.*, examined the influence of pruning intensities and time of pruning on growth and yield parameters of guava cv. Sardar. They performed pruning at different levels *i.e.*, removal of 25, 50 and 75 per cent of shoot growth during 1st week of April, 3rd week of April and 1st week of May. They observed that light pruning intensity *i.e.*, removal of 25 of shoot growth during third week of April resulted in maximum canopy spread (1.43 m) in East-West direction and maximum canopy spread (1.35 m) in North-South direction was recorded when pruning was done in 1st week of May.

Meena *et al.* (2017) performed different pruning intensities *i.e.*, removal of 15, 30, 45 and 60 cm of shoot growth from the tip in the month of April, May and June along with unpruned plants (control) in guava cv. Lalit. Their results indicated that the plants which were pruned to 45 cm in the month of May exhibited maximum increase in plant canopy spread (30.00 cm) in E-W direction while, maximum canopy spread (26.50 cm) in N-S direction was indicated by plants subjected to 45 cm pruning in the month of April followed by 15 cm pruning intensity during May (24.00 cm). However, minimum increase in canopy spread in E-W (13.50 cm) and N-S (14.50 cm) direction was observed in unpruned plants (control). Patil *et al.* (2018) studied the influence of pruning severity and time on growth, flowering and fruit set in hastha

bahar of acid lime. The experiment included pruning intensities *viz.*, removal of 5, 10 and 15 cm of shoot carried out at different pruning dates *i.e.*, 1st September, 15th September and 1st October. They found that plants pruned to 15 cm on 1st September produced maximum per cent increase in mean canopy spread (11.31 %) followed by plants pruned to 10 cm on 1st September (10.18 %) while minimum per cent increase in mean canopy spread was found in plants which were subjected to 5 cm pruning during 1st October.

Lian *et al.* (2019) assessed the influence of different pruning intensities *viz.*, removal of 25, 50 and 75 per cent of shoot length from the tip at different times *viz.*, mid- April, mid- May and mid- June on growth and yield parameters of guava cv. L-49. Their results revealed that with the increase in the pruning intensity, there was significant decrease in the plant spread. They observed that lightly pruned plants (25 %) induced maximum plant spread (119.33 cm) in E-W and in N-S direction (123.33 cm) when pruned in mid- April and mid- May, respectively. Tirkey *et al.* (2019) conducted an experiment to assess the influence of pruning time on growth attributes of guava cv. Allahabad Safeda planted under agro climatic conditions of Allahabad. They performed half shoot pruning during mid- August, 1st week in September, mid- September, 1st week in October, mid- October, 1st week in November and mid- November along with unpruned plants (control). They reported maximum canopy spread (96.33 cm) in plants which were pruned during mid- September while, minimum canopy spread (87.33 cm) was observed in unpruned plants.

2.1.1.4 Trunk girth

Mehta *et al.* (2012) evaluated the influence of pruning intensities *viz.*, pruning to 60, 80 per cent of canopy height, pruning to 50 per cent shoot length and unpruned plants (control) at different pruning dates *viz.*, pruning once in May, October and thrice in March- May- October in cv. Sardar guava. They obtained maximum trunk girth (42.78 mm) in plants which were 80 per cent pruned in the month of May followed by unpruned plants (42.48 mm) whereas, minimum trunk girth (40.63 mm) was produced by plants pruned thrice during March- May and October.

Shiranal R. (2015) examined the effect of different pruning intensities *viz.*, severe pruning (retaining 15 cm shoot), light pruning (retaining 30 cm shoot) and very

light pruning (retaining 45 cm shoot) along with unpruned plants (control) in guava cv. Sardar. The results revealed that plants subjected to very light pruning resulted in maximum trunk girth (28.04 cm) followed by lightly pruned plants (27.31 cm).

Kindo *et al.* (2016) studied the influence of different pruning intensities *i.e.*, retaining one and two leaf pair at the base of the shoot, retaining one terminal leaf pair, retaining terminal two leaf pairs, flower bud thinning conducted in the first week of May along with control on growth, yield and fruit quality of guava cv. Pant Prabhat. The results revealed that maximum annual increase in trunk diameter (1.85 cm) was observed in plants subjected to flower bud thinning. Purnima J. (2016) studied the response of different pruning intensities *viz.*, removal of 10, 15 and 20 cm of shoot growth from the terminal portion of shoot during *viz.*, 3rd week (August – December) and 2nd week (September – January) on vegetative growth characteristics of Sardar guava. The results revealed that unpruned plants (control) exhibited maximum collar girth (9.22 cm) followed by the plants which were subjected to 10 cm pruning (9.00 cm) during 3rd week (August –December) while, 20 cm pruning done in 3rd week (August – December) resulted in minimum collar girth (6.92 cm).

Thakre *et al.* (2016) conducted an experiment to ascertain the influence of different pruning forms *i.e.*, flower bud thinning by hand, flower bud thinning by hand followed by removal of terminal one leaf pair, removal of leaves and flower buds by hand, retaining one leaf pair at the top, removal of all leaves and flowers by hand, one leaf pair shoot pruning, full shoot pruning, one leaf pair pruning of fruited shoots only along with control on growth and yield attributes of guava cv. Pant Prabhat. They registered maximum annual increase in trunk girth (1.32 cm) in plants subjected to flower bud thinning whereas, one leaf pair pruning of fruited shoots exhibited minimum increase in trunk girth (1.01 cm).

Lian *et al.* (2019) evaluated the effect of varied pruning intensities *viz.*, 25, 50 and 75 per cent pruning from shoot tip performed during mid- April, mid- May and mid- June on the vegetative growth characteristics of guava cv. L-49. They reported maximum increase in collar girth (2.43 cm) in plants pruned at 25 per cent from the shoot tip during mid- April followed by the plants pruned to 50 per cent (2.27 cm)

during mid- April and minimum increase in collar girth (2.03 cm) was observed in severely pruned plants during mid- June.

2.1.1.5 Shoot length

Kumar *et al.* (2014) reported an increase in shoot length with the increase in pruning intensity in ber cv. Banarasi Karaka. They performed pruning on one year old shoots at different levels *i.e.*, 10, 20, 30, 40, 50 and 60 per cent removal of previous season growth in the 3rd week of May along with unpruned plants (control). They obtained maximum shoot length (100.29 cm) in plants which were pruned to 60 per cent followed by 50 per cent (86.52 %) and minimum shoot length (25.94 cm) was observed in unpruned plants. Solanki *et al.* (2016) analysed the impact of different pruning time and intensity on vegetative growth characteristics of mango cv. Kesar. Different pruning intensities *viz.*, 25 cm, 50 cm and 75 cm along with control were tried on different dates *i.e.*, 1st fortnight of June, 2nd fortnight of June, 1st fortnight of July and 2nd fortnight of July. Their results showed that 25 cm pruning intensity induced maximum shoot length (31.64 cm) while, minimum shoot length (28.08 cm) was observed in unpruned plants. Among various pruning dates, plants pruned during 1st fortnight of July exerted maximum shoot length (31.97 cm) followed by the plants pruned during 2nd fortnight of July (31.40 cm).

Samant *et al.* (2016) investigated the influence of shoot pruning and branch bending on crop regulation in guava cv. L-49. The plants were subjected to 30, 50, 70 per cent shoot pruning and control in the month of May. Their study indicated that the 70 per cent shoot pruning was found superior over other treatments and produced maximum length of the flowering shoots (58.85 cm) followed by 50 per cent shoot pruning (56.98 cm). Bhuva *et al.* (2018) carried out an experiment on standardization of pruning severity and crop load on growth and yield parameters of pomegranate var. Bhagwa. The treatments comprised of pruning of 15 cm + 30 fruits retained/ plant, 15 cm pruning + 40 fruits retained, 15 cm pruning + 50 fruits retained, 30 cm pruning + 30 fruits retained, 30 cm pruning + 40 fruits retained and 30 cm pruning + 50 fruits retained. Maximum shoot length (48.05 cm) was recorded in plants pruned to 15 cm with 40 fruits / plant followed by lightly pruned plants *i.e.*, 15 cm pruning + retaining 30 fruits/ plant (43.85 cm) whereas, minimum shoot length (38.05 cm) was obtained in unpruned plants.

Gurung *et al.* (2019) carried out an experiment to study the influence of pruning time and intensity on vegetative attributes of guava cv. Khaja. They performed heading back at 1, 2 and 3 m height from the ground level in the month of April and May along with unpruned plants (control). Their results revealed that heading back done at 2 m height in the month of April resulted in maximum shoot length (67.54 cm) followed by heading back at 3 m height (55.67 cm). Lian *et al.* (2019) reported increase in the shoot length with the increase in the pruning intensity. They performed different pruning intensities *viz.*, 25, 50 and 75 per cent of shoot length from the tip at different times *i.e.*, mid- April, mid- May and mid- June They found maximum shoot length (24.62 cm) in the plants pruned to 75 per cent pruning intensity during mid- May followed by severely pruned plants during mid- April (25.53 cm). However, minimum shoot length (19.33 cm) was produced by lightly pruned plants during mid- June.

Pandey *et al.* (2020) assessed the effect of different pruning intensities *viz.*, 20, 30 and 50 per cent shoot pruning performed in mid- February, mid- May along with control on guava. They reported maximum length of the sprouted shoots (57.65 cm) in plants which were pruned to 50 per cent shoot pruning during mid- February followed by pruning in mid- May (52.75 cm) while, minimum shoot length (42.15 cm) was observed in unpruned plants. Singh and Grover (2020) in an investigation studied the influence of nodal pruning *viz.*, removal of shoot tip up to 0, 4th, 6th and 8th node on vegetative and reproductive parameters of guava cv. Sardar done during the first week of March. They obtained maximum shoot length (9.56 cm) in plants subjected to 8th node pruning followed by 6th node pruning (8.72 cm) whereas, minimum shoot length (7.30 cm) was observed in unpruned plants.

Kumar *et al.* (2021) studied the effect of pruning intensities *viz.*, 25, 50 and 75 per cent removal of shoots along with unpruned plants and time (1st May, 1st June and 1st July) on vegetative growth characteristics of guava cv. Shweta. Their observations showed that severely pruned plants (75 %) on 1st May resulted in maximum shoot length (72.87 cm) followed by 50 per cent pruning intensity (64.67 cm) while, unpruned plants induced minimum shoot length (43.17 cm). Singh *et al.* (2021) conducted an experiment to assess the removal of 30 and 60 per cent of annual shoot growth at different times *i.e.*, 20th May, 5th June and 20th June on vegetative growth

attributes of guava cv. L-49. They reported maximum shoot length (10.74 cm) in plants which were pruned to 60 per cent on 5th June, followed by plants pruned on 20th May (10.54 cm) while, plants pruned on 20th May resulted in minimum shoot length (9.41 cm).

2.1.1.6 Shoot diameter

Aniruddha (2014) laid out an experiment to study the influence of pruning intensities (25, 50 and 75 %) and pruning time (1st, 2nd, 3rd and 4th week of May) along with control on growth attributes of guava cv. Sardar. From their study, they concluded that 75 per cent pruning intensity done during 2nd week of May resulted in maximum stem diameter while, minimum stem diameter (2.27 cm) was recorded in unpruned plants (control). Kumar *et al.* (2014) investigated the performance of different pruning severities *i.e.*, removal of 10, 20, 30, 40, 50 and 60 per cent previous season growth along with unpruned plants (control) conducted in the 3rd week of May on growth and yield parameters of ber cv. Banarasi Karaka. Their observations showed that plants pruned to 30 per cent of their previous season growth resulted in maximum shoot diameter (21.24 cm) followed by 40 per cent pruned plants (20.56 cm). However, minimum shoot diameter (18.26 cm) was reported in unpruned plants (control).

Bhagat (2014) examined the effect of pruning on growth and quality parameters of four guava cultivars *viz.*, Arka Amulya, Arka Mridula, L-49 and Allahabad safeda. They tried different pruning intensities *i.e.*, removal of 2, 4 and 6 cm diameter shoot along with unpruned plants (control) in the month of June- July. The study revealed that plants subjected to pruning of 6 cm diameter shoot resulted in maximum shoot diameter in Arka Amulya (0.81 cm), Arka Mridula (0.56 cm), L-49 (0.85 cm) and Allahabad safeda (0.93 cm).

Sawant *et al.* (2018) studied the effect of pruning intensities *viz.*, retention of the main trunk up to 1m along with primary branches to 1 m and secondary branches to 0.50 m, retention of main trunk up to 1 m along with primary and secondary branches to 1 m, heading back of tertiary branches at 25, 33, 50 and 75 per cent portion along with control on vegetative growth parameters of guava cv. Sardar. Study revealed that plants retaining up to 1 m from trunk along 1 m primary branches and 0.50 m of secondary branches produced maximum shoot diameter (0.94 cm).

Supanjani *et al.* (2019) executed different pruning intensities to see its effect on growth and flowering of guava cv. Crystal. The plants were subjected to varied pruning intensities *viz.*, retaining 10, 20, 30 and 40 cm of shoot from the base along with control. From their study, they concluded that plants subjected to 10 cm pruning resulted in maximum branch diameter (0.43 mm) followed by unpruned plants (0.40 mm). Nautiyal *et al.* (2020) studied the influence of pruning severity *viz.*, One leaf pair shoot pruning, Two leaf pairs shoot pruning, Three leaf pairs shoot pruning, Thinning out of non-fruiting shoots + One leaf pair shoot pruning, Thinning out of non-fruiting shoots + Two leaf pairs shoot pruning, Thinning out of non-fruiting shoots + Three leaf pairs shoot pruning, Thinning out of non-fruiting shoots only done in the last week of April along with unpruned plants in high density planting of guava cv. Pant Prabhat. Their results thus revealed that plants subjected to Thinning out of non-fruiting shoots + One leaf pair shoot pruning produced maximum increase in annual stem diameter (1.74 cm) at 2 x 2 m spacing while, minimum increase in annual stem diameter (1.13 cm) was recorded in unpruned plants.

2.1.1.8 Trunk cross- sectional area

Demirtas *et al.* (2010) executed different pruning intensities *viz.*, pre-harvest summer, pre- harvest summer + winter, postharvest summer, post- harvest summer + winter and winter pruning on growth, fruit quality and yield attributes of apricot cv. hacihaliloglu. Their observations showed that plants subjected to pre- harvest summer and winter pruning resulted in maximum trunk cross- sectional area (502.50 cm²) followed by pre- harvest summer pruning (484.1 cm²). İkinci (2014) studied the influence of pre and post harvest summer pruning on growth and yield parameters of two peach cultivars (Early red and Glohaven). The current season growth of the plants was headed back to about 10 cm on different dates *viz.*, 7th May, 7th June, 7th July and 7th August along with winter pruning and unpruned plants (control). The study revealed that maximum increase in trunk cross- sectional area (33.45 cm²) was observed in unpruned plants followed by plants subjected to winter pruning (32.68 cm²) in Early red cultivar of peach. However, in Glohaven cultivar maximum increment in trunk cross- sectional area (29.07 cm²) was recorded in plants subjected to winter pruning followed by unpruned plants (23.39 cm²).

2.1.2 Reproductive growth characteristics

2.1.2.1 Days taken for flower emergence

Gopu *et al.* (2014) tried varied pruning intensities *viz.*, retention of 70, 60 and 50 cm of past season growth from the base, 50 per cent removal of past season growth, complete removal of previous season growth along with control (tipping of previous season's growth) performed during last week of June on reproductive growth characteristics of mango cv. Alphonso. The results revealed that control plants took minimum time for first flower emergence (168.66) followed by plants subjected to 50 per cent removal of previous season growth while, maximum time (197.82) was taken by severely pruned plants (complete removal of previous season growth).

Adhikari and Kandel (2015) evaluated the effect of pruning intensities *viz.*, removal of 10, 20 and 30 cm from the tips of one year old shoots along with control and pruning time *i.e.*, mid- April, early- May and mid- May on growth, flowering and yield parameters of guava cv. L-49. The plants were subjected to different pruning levels at different pruning. Their observations revealed that the unpruned plants (control) showed earliest flower emergence (115.00 days) whereas, plants pruned to 30 cm during mid- May took maximum time for flower emergence (166.00 days). Awasthy and Arumugam (2017) evaluated the effect of different pruning intensities *viz.*, pruning 10, 20 and 30 cm of apical shoots during mid- March, mid- April and mid- May. Their observations indicated that the plants pruned to 30 cm during mid- March took minimum time (54.12 days) for flower emergence followed by the plants pruned to 20 cm during mid- March (74.64 days). However, plants under control took maximum time for flower initiation (93.92 days).

Kumar *et al.* (2017) studied the effect of pruning intensities *viz.*, 20, 40, 60 and 80 per cent removal of current season shoot performed twice during 15th February and 15th April on reproductive attributes of guava cv. Pant Prabhat. They reported that the plants pruned to 40 per cent of their current season's shoot growth took minimum time flower emergence (58.81 days) followed by 20 per cent pruning intensity (58.81 days) while, severely pruned plants took maximum time for flower emergence (66.71 days). Singh and Varu (2017) evaluated the influence of different pruning dates on flowering, fruiting and yield parameters on winter season guava cv. Bhavnagar Red. The plants were pruned to 25 per cent of one-year old current season growth shoot on

four different dates *i.e.*, 20th April pruning, 10th May, 30th May along with control. The results revealed that unpruned plants resulted in earliest flower emergence (53.75 days) followed by plants pruned on 30th May (57.58 days) and maximum time for flower emergence was observed in plants pruned on 20th April (63.75 days).

Widyastuti *et al.* (2019) conducted an experiment to study the influence of different pruning dates on crop regulation in crystal guava. They carried out pruning by removal of leaves upto 6 leaf pair from the base during April, May, June, and July along with unpruned plants (control). Plants pruned during May showed earliest flower emergence (25.00 days) while, unpruned plants took maximum time (38.67 days) for flower induction. Shinde *et al.* (2020) executed different pruning intensities *viz.*, removal of 5, 10, 15, 20, 25, 30 cm shoots in the first week of May along with control on flowering and quality parameters of guava cv. Sardar. Their results revealed that unpruned plants (control) showed earliest flower emergence (39.63 days) followed by 10 cm pruning intensity (40.78) while, plants pruned to 5 cm pruning intensity took maximum time (42.56 days) for flower emergence.

2.1.2.2 Number of flowers

Pilania *et al.* (2010) studied the effect of pruning intensities *i.e.*, 25, 50 and 75 per cent shoot pruning of previous season growth done in the month of February on vegetative and reproductive growth characteristics of guava cv. Lalit. Their results revealed that 25 per cent of shoot pruning resulted in maximum number of flowers per shoot (50.93) followed by 50 per cent pruning intensity (45.97) and minimum number of flowers per shoot (39.07) was observed in unpruned plants (control). Joshi *et al.* (2014) investigated the effect of pruning intensities *viz.*, removal of $\frac{1}{4}$ th, $\frac{1}{2}$ th and $\frac{3}{4}$ th current season shoot performed in the last week of April along with unpruned plants (control) on reproductive and yield attributes of guava cv. Pant Prabhat. The results revealed that the plants subjected to $\frac{3}{4}$ th shoot pruning produced maximum number of flowering buds (67.50) followed by half shoot pruning (63.50) while, minimum number of flower buds per plant (44.25) was observed in unpruned plants.

Mahesh *et al.* (2016) carried out an experiment to evaluate the effect of pruning intensities (removal of 25, 50 and 75 per cent of shoot growth from the

terminal portion) and pruning time (1st week of April, 3rd week of April and 1st week of May) on growth and yield attributes of guava cv. Sardar. They obtained maximum number of flowers per plant (51.33) with 25 per cent shoot pruning done during 3rd week of April while, minimum number of flowers per plant (29.06) was reported in severely pruned plants (75%) during 1st week of May. Meena *et al.* (2017) examined the effect of different pruning intensities *viz.*, 15, 30, 45, 60 cm shoot pruning from the tip along with unpruned plants (control) and pruning time *i.e.*, April, May and June on vegetative and reproductive parameters of guava cv. Lalit. Their Results revealed that the plants subjected to 45 cm shoot pruning during May produced maximum number of flowers per shoot (13.67) followed by the plants pruned to 30 cm in the month of May (12.33) while, minimum number of flowers per shoot (6.00) were observed in unpruned plants.

Kumar *et al.* (2017) investigated the effect of different pruning intensities (removal of 20, 40, 60 and 80 per cent of current season's shoot growth) performed twice during February and April along with unpruned plants (control) on reproductive and yield attributes of guava cv. Pant Prabhat. Their study indicated that 40 per cent shoot pruning produced maximum number of flowers per tree (183.03) followed by 60 per cent pruning (173.51) while, the unpruned plants (control) induced minimum number of flowers per tree (137.60). Patil *et al.* (2018) examined the influence of pruning severity (removal of 5, 10 and 15 cm of shoot from the apex) and time of pruning (1st September, 15th September and 1st October) on growth, flowering and fruit set in hastha bahar of acid lime. From their study, they concluded that plants which were pruned to 10 cm from shoot apex on 15th September induced maximum number of flowers per meter shoot (164.66) followed by the plants pruned on 1st September (150.87). However, minimum number of flowers per meter shoot (89.99) was exhibited by plants which were subjected to 5 cm shoot pruning on 1st October.

Kumar *et al.* (2020) laid out an experiment to assess the effect of pruning intensities *viz.*, 10, 20, 30, 40, 50 and 60 cm shoot pruning performed during the 1st week of September along with unpruned plants (control) on growth and reproductive characteristics of guava cv. Lalit. From their study, they inferred that the maximum number of flowers per plant (95.66) was exhibited by 30 cm shoot pruning followed

by 20 cm shoot pruning (91.67) whereas, least number of flowers per plant (82.67) was recorded in unpruned plants.

Kaur *et al.* (2020) investigated the influence of different pruning intensities *i.e.*, 10, 20 and 30 cm shoot pruning from the tip performed at different pruning dates *viz.*, 30th April, 15th May, 30th May and 15th May on flowering and yield attributes of guava cv. Allahabad safeda. The results revealed that plants which were pruned to 20 cm on 30th April produced maximum number of flowers per tree (288.30) followed by plants subjected to 10 cm pruning (282.30) whereas, minimum number of flowers per tree (220.53) was produced in plants which were pruned to 10 cm on 30th May. Pandey *et al.* (2020) performed different pruning intensities *viz.*, 20, 30 and 50 per cent shoot pruning along with control done during mid- February and mid- May on six-year-old guava cv. Shweta. They opined that maximum number of flowers per plant (279.35) was produced in plants subjected to 50 per cent shoot pruning while, minimum number of flowers per plant (121.88) was reported in unpruned plants (control).

2.1.2.3 Fruit set

Sahar *et al.* (2014) conducted an experiment to evaluate the effect of pruning intensities (removal of 10 and 20 cm new shoot from the apical portion) and time (15th of May, June and July) on reproductive and yield attributes of guava. They found that the plants which were pruned to 10 cm on 15th May resulted in maximum fruit set (0.75 %) followed by the plants subjected to 10 cm pruning on 15th June (0.67 %) while, minimum fruit set (0.43 %) was observed in lightly pruned plants on 15th July.

Sharma (2014) studied the influence of pruning intensities on growth, yield and quality attributes of apple cv. Starking delicious. They performed different pruning intensities *viz.*, No heading back only thinning out, $\frac{1}{4}$ heading back and thinning out, $\frac{1}{2}$ heading back and thinning out, $\frac{3}{4}$ heading back and thinning out, Farmers practice (more heading back and less thinning out during 2nd week of January). They recorded highest fruit set (21.20 %) in plants subjected to $\frac{1}{4}$ heading back and thinning out whereas, minimum fruit set (18.75 %) was observed in control plants. Sah *et al.* (2018) assessed the effect of time of pruning on vegetative and

reproductive growth characteristics of guava cv. Pant Prabhat. They performed half shoot pruning in April, July, October, April- July, April- October, July- October, April- July- October along with unpruned plants (control). They reported that maximum fruit set (67.44 %) in plants pruned during October followed by plants pruned in the month of April (67.30 %) whereas, minimum fruit set (36.02 %) was observed in plants pruned thrice during April- July- October.

Samant (2016) laid out an experiment to ascertain the influence of different levels of summer and winter pruning *i.e.*, 30, 50 and 70 per cent shoot pruning performed in the month of May and December respectively on reproductive and quality attributes of guava cv. Sardar. Their observations showed that plants subjected to 70 per cent shoot pruning during winter resulted in maximum fruit set (64.03 %) followed by 70 per cent shoot pruning (63.87 %) during summer whereas, minimum fruit set was observed in unpruned plants (60.96 %).

Choudhary and Dhakare (2018) tried different pruning intensities *viz.*, pruning at 30, 45, 60, 75, 90 cm on main shoot performed after leaf fall of previous season growth along with unpruned plants (control) on growth and yield attributes of custard apple. They found maximum fruit set (69.47 %) in plants pruned at 30 cm of shoot length followed by 45 cm pruning (65.15 %) while, minimum fruit set (49.58 %) was observed in plants pruned to 90 cm shoot length. Sharma and Singh (2018) evaluated the effect of different pruning intensities *i.e.*, retaining 15, 30, 45 and 60 cm of shoot length carried out during dormant season along with unpruned plants (control) on reproductive and yield attributes of pomegranate cv. Kandhari Kabuli. They obtained highest fruit set (54.73 %) in control plants followed by plants retaining 60 cm shoot length (53.22 %) while, minimum fruit set (45.96 %) was observed in plants pruned up to 15 cm shoot.

Singh and Grover (2020) studied the influence of nodal pruning *viz.*, removal of shoot tip up to 0, 4th, 6th and 8th node performed during the first week of March on vegetative and reproductive growth characteristics of guava cv. Sardar. Their study revealed that plants pruned upto 6th node resulted in highest fruit set (70.00 %) followed by the plants pruned upto 8th node (68.50 %) while, lowest fruit set (62.80 %) was reported in unpruned plants.

Kumar *et al.* (2021) investigated the effect of different pruning intensities *viz.*, 25, 50 and 75 per cent shoot pruning along with control performed during different times *i.e.*, 1st of May, June and July. They found that 50 per cent shoot pruning done during 1st week of July resulted in maximum fruit set (69.40 %) followed by pruning done on 1st May (68.40 %) whereas, minimum fruit set (50.75 %) was recorded with 75 per cent shoot pruning performed during 1st June.

2.1.2.4 Fruit yield

Brar *et al.* (2007) executed an experiment to ascertain the influence of pruning levels *viz.*, 15, 30 and 45 cm shoot pruning from the shoot apex along with unpruned plants on fruit yield and quality of guava cv. Sardar. They obtained maximum number of fruits per plant (496) and fruit yield (82.3 kg/tree) during winter season with 15 cm pruning. Tiwari and Lal (2007) performed an experiment to assess the effect of pruning intensities *viz.*, retaining of one leaf pair and two leaf pair at the base of the new shoot growth performed in the first week of May along with control in guava cv. Sardar. They observed maximum winter season fruit yield (88.00 kg/ tree) with one leaf pair pruning while minimum fruit yield (4.50 kg/ tree) was observed in control plants.

Prakash *et al.* (2012) evaluated the effect of summer pruning on yield and quality attributes of guava cv. Sardar. Plants were subjected to four different pruning intensities in the month of April *i.e.*, 25, 33, 50 and 75 per cent removal of current season shoot growth along with unpruned plants (control). From their results, they concluded that the plants pruned to 33 per cent of their current season shoot growth produced in maximum fruit yield (47.63 kg/tree) followed by the plants pruned to 50 per cent of their shoot growth (45.98 kg/tree). Sharma *et al.* (2013) studied the influence of different pruning intensities *i.e.*, retaining one, two and three leaf pair at the base of the shoot during last fortnight of April on yield and quality attributes of guava cv. L-49. Their results revealed that one leaf pruning was found most effective in decreasing rainy season yield and subsequently increasing winter season fruit yield. Maximum winter season guava fruit yield (78.20 kg/tree) was found in trees subjected to one leaf pair pruning followed by two (66.23 kg/tree) and three leaf pair pruning (50.76 kg/tree).

Satya *et al.* (2015) investigated the effect of pruning time on yield and physico- chemical attributes of guava cv. L-49 planted under different spacing. Plants were pruned on different dates *viz.*, 1st February, 1st March, 1st April, 1st may, 1st June and no pruning (control). Maximum yield with respect to number of fruits per plant (83.00) and yield per plant (14.84 kg) was recorded in plants pruned on 1st April while minimum number of fruits per plant (29.83) and fruit yield per plant (4.84 kg) was obtained in plants pruned during 1st May.

Nikumbhe *et al.* (2017) evaluated the impact of pruning time on vegetative characteristics and yield of seven different varieties of guava. The plants were pruned to 75 per cent of current season's growth at different time's *i.e.*, 15th May, 15th June, 15th July, 15th August, 15th September along with control. From their study, they concluded that the plants pruned on 15th July resulted in maximum fruit yield (28.06 kg/ plant) which was found significantly superior to other treatments whereas minimum fruit yield (14.41 kg/ plant) was obtained in plants pruned on 15th September. Das *et al.* (2018) evaluated the influence of pruning intensities (60 % and 80 % of canopy height) done at different pruning times *i.e.*, pruning once in May, October and thrice a year in March, May and October in guava cv. Sardar. Their results revealed that plants pruned to 60 per cent of canopy height in the month of May resulted in maximum fruit yield during winter season (2.66 t/ ha) followed by 80 per cent pruning during May (2.49 t/ ha).

Ezhilarasi *et al.* (2019) assessed the influence of different pruning levels on yield attributes of guava cv. Lucknow- 49. The plants were subjected to different prunings *viz.*, one, two and three leaf pair shoot removal from the tip of the current season shoot along with unpruned plants (control) during last week of April. From their study they inferred that maximum fruit yield per tree (23.75 kg/ tree) was recorded in plants subjected to one leaf pair shoot pruning followed by two leaf pair shoot pruning (19.22 kg/ tree) while, minimum fruit yield (12.45 kg/ tree) was observed in unpruned plants.

2.1.3 Fruit quality attributes

2.1.3.1 Physical characteristics

Basu *et al.* (2007) carried out an experiment to study the influence of different pruning dates on rejuvenation of old guava orchard cv. L-49. Their observations showed that the pruning dates had significant effect on improving physical characteristics of guava fruits. May pruning resulted in fruits with maximum fruit length (7.35 cm), fruit diameter (7.41 cm) and fruit weight (228.33 g) while the minimum fruit length (5.98 cm), fruit diameter (5.51 cm) and fruit weight (183.33 g) were recorded in fruits obtained from unpruned plants (control).

Kumar and Rattanpal (2010) examined the effect of pruning intensities (removal of $\frac{1}{2}$, $\frac{1}{3}$ and $\frac{1}{4}$ th vegetative growth) along with unpruned plants (control) in the month of April on vegetative and biochemical attributes of guava cv. Sardar. They opined that pruning had a significant effect on fruit quality parameters. Highest fruit diameter (6.10 cm), fruit length (7.00 cm) and fruit weight (189.10 g) was found in the fruits collected from the plants subjected to the removal of $\frac{1}{2}$ of their vegetative growth. Pilia *et al.* (2010) studied the effect of different pruning intensities *viz.*, 25, 50 and 75 per cent removal of previous season growth during February along with unpruned plants (control) on quality attributes of guava cv. Lalit. Their observations showed that 75 per cent shoot pruning produced fruits with maximum fruit diameter (5.03 cm) and fruit weight (127.79 g) whereas, minimum fruit diameter (4.55 cm) and fruit weight (101.36 g) was obtained in fruits harvested from unpruned plants.

Singh *et al.* (2010) advocated the influence of different pruning intensities *viz.*, light pruning (removal of all branches up to 30 cm from the shoot apex), moderate pruning (removal of all branches up to 60 cm from the shoot apex) and severe pruning (removal of all branches up to 90 cm from the shoot apex) along with unpruned plants (control) done in the month of August on quality attributes of three varieties of mango (Amrapali, Mallika, Dashehari). Their observations indicated that the lightly pruned plants produced fruits with maximum fruit weight (187.00 g) while, maximum fruit volume (164.00 ml) was recorded in fruits harvested from severely pruned trees.

Prakash *et al.* (2012) evaluated the effect of summer pruning on yield and quality attributes of guava cv. Sardar. Plants were subjected to different pruning intensities *i.e.*, removal of 25, 33, 50 and 75 per cent current season shoot growth along with unpruned plants (control) executed in the month of April and reported that the plants subjected to 33 per cent shoot pruning produced fruits with maximum diameter (72.40 mm), fruit length (72.40 mm) and fruit weight (116.24 g) while, minimum fruit length (61.50 mm), fruit diameter (56.40 mm) and fruit weight (102.25 g) was found in fruits harvested from unpruned plants (control). Lakpathi *et al.* (2013) studied the influence of pruning intensities (leaving 10, 20 and 30 cm from the base of the shoot and retaining 30, 40 and 50 fruits) performed in the 3rd week of June. They obtained maximum fruit diameter (7.87 cm) and fruit weight (292.24 g) in fruits harvested from plants subjected to 10 cm pruning from the base of the shoot and retaining 30 fruits. Minimum fruit diameter (6.15 cm) was observed in fruits produced from unpruned plants whereas, minimum fruit weight (209.34 g) was found in fruits obtained from plants which were pruned to 20 cm and having 50 fruits.

Sahar *et al.* (2014) studied the effect of pruning intensities and time on reproductive and quality parameters of guava. The plants were pruned to 10 and 20 cm from the apical portion of the new shoots at three different times *i.e.*, 15th of May, June, and July. They recorded maximum fruit weight (108.19 g) and fruit volume (113.33 cm³) in fruits obtained from severely pruned plants (20 cm) on 15th May while, minimum fruit weight (90.88 g) and fruit volume (95.00 cm³) was found in fruits picked from unpruned plants. Bhagwati *et al.* (2015) examined the effect of different pruning intensities *viz.*, light, moderate and severe on physico-chemical parameters of guava. Their observations revealed that severely pruned plants produced fruits with maximum fruit diameter (7.15 cm) and fruit weight (300.20 g) followed by the fruits obtained from moderately pruned plants (6.45 cm) and (298.10 g) whereas, minimum fruit diameter (5.89 cm) and fruit weight (221.30 g) was found in fruits produced from unpruned plants.

Satya *et al.* (2015) reported a significant effect of pruning time on fruit physical properties of guava cv. L-49. They performed pruning on different dates *viz.*, 1st February, 1st March, 1st April, 1st may, 1st June and no pruning (control). They found maximum fruit weight (178.16 g), fruit length (7.15 cm), fruit diameter (6.94

cm) and fruit volume (189.00 cm³) in fruits harvested from plants pruned on 1st April followed by plants pruned on 1st March whereas, minimum fruit weight (158.20 g), fruit length (6.05 cm), fruit diameter (6.17 cm) and fruit volume (159.00 cm³) was found in fruits obtained from unpruned plants. Balmohan *et al.* (2019) investigated the influence of pruning intensities *viz.*, 10, 20 and 30 cm pruning along with control on yield and quality parameters of guava cv. L- 49. They recorded maximum fruit weight (183.93 g) and fruit length (6.69 cm) in fruits obtained from 10 cm pruned plants.

Pandey *et al.* (2020) executed different pruning intensities *viz.*, 20, 30 and 50 per cent shoot pruning along with control during mid- February and mid- May on six-year-old guava cv. Shweta. They observed a significant improvement in the physical attributes of guava fruits with the increase in the level of pruning. Maximum fruit weight (205.00 g), fruit volume (256.95 ml) and fruit length (13.01 cm) were observed in fruits obtained from plants subjected to 50 per cent shoot pruning during mid- May while, minimum fruit weight (142.48 g), fruit length (6.03 cm) and fruit volume (184.03 ml) was found in fruits collected from unpruned plants. Shinde *et al.* (2020) tried different pruning intensities *viz.*, 5, 10, 15, 20, 25, 30 cm of current season shoots during the 1st week of May along with control on flowering and quality attributes of guava cv. Sardar. They reported maximum fruit weight (293.39 g) in fruits obtained from the plants subjected to 30 cm pruning intensity followed by 25 cm pruning (280.30 g) while, minimum fruit weight (201.96 g) was found in fruits picked from unpruned plants.

2.1.3.2 Qualitative characteristics

Singh *et al.* (2010) executed different pruning intensities *viz.*, light pruning (removing branches upto 30 cm from the apex), moderate pruning (removing branches upto 60 cm from the apex) and severe pruning (removing branches upto 90 cm) along with unpruned plants during mid- August on mango. They recorded maximum TSS (21.7 °B) and total sugars (16.8 %) in fruits collected from severely pruned plants while, highest TSS/ acid ratio (111) and lowest acidity (0.22 %) was observed in fruits obtained from lightly pruned plants. Sahar *et al.* (2014) assessed the effect of pruning intensities (10 and 20 cm from the apical portion of the new shoots) and time (15th of May, June, and July) on reproductive and quality attributes of guava. They observed highest TSS (9.66 %), total sugars (6.41 %) and vitamin C (74.89

mg/100 ml) in fruits picked from plants pruned to 10 cm on 15th May. However, minimum TSS (7 %) and total sugars (4.84 %) was found in fruits obtained from plants pruned to 10 cm during July and minimum vitamin C (56.73 mg/ 100 ml) was observed in fruits picked from plants subjected to 20 cm pruning during July.

Samant *et al.* (2016) tried different pruning intensities *viz.*, 30, 50 and 70 per cent shoot pruning done in the month of May along with unpruned plants in guava cv. L-49. They recorded maximum TSS (9.45 °B) and vitamin C (191.60 mg/100 g of pulp) in fruits obtained from plants pruned to 50 per cent and maximum TSS/ acid ratio (20.64) was reported with 70 per cent shoot pruning. Minimum TSS (9.15 °B) was found with 30 per cent shoot pruning while, minimum vitamin C (182.46 mg/ 100 g) was observed in fruits collected from plants subjected to 70 per cent shoot pruning. Sharma *et al.* (2016) examined the influence of various crop regulation treatments on yield and quality attributes of guava cv. Allahabad Safeda. Plants were pruned to different levels *viz.*, retaining 1 leaf pair, 2 leaf pair and three leaf pair from the base of the shoots during last fortnight of April. Their study revealed that fruits obtained during winter season from plants retaining 1 leaf pair at the base of the shoot resulted in maximum TSS (13.40 °B), ascorbic acid (240.45 mg/ 100 g) and minimum acidity (0.47 %).

Jayswal *et al.* (2017) investigated the influence of pruning intensities *viz.*, 20cm, 40 cm pruning from shoot apex done on 24th May along with unpruned plants (control) on quality attributes of guava cv. Allahabad Safeda. Their findings indicated that fruit quality attributes improved with the increased level of pruning and reported highest TSS (10.96 °B), ascorbic acid (241 mg/100 g), total sugars (8.74 %), reducing sugars (5.10 %) and non- reducing sugars (3.64 %) in fruits harvested from 30 cm pruned plants. Kumar *et al.* (2017) evaluated the effect of pruning intensities *i.e.*, removal of 20, 40 60 and 80 % current season shoot growth along with control) done twice during February and April and concluded that the 40 per cent current season's shoot pruning was found superior over other treatments and produced fruits with maximum TSS (10.03 %), total sugars (7.97 %), reducing sugars (4.08 %), ascorbic acid (213.32 mg/100 g pulp), TSS/acid ratio (50.85) and minimum acidity (0.20 %).

Kadam *et al.* (2018) evaluated the effect of pruning intensities *i.e.*, *i.e.*, 5, 10, 15, 20, 25 cm along with control carried out during 1st week of April on quality parameters of custard apple cv. Dharur-6. The results revealed that plants pruned to 20 cm pruning intensity produced fruits having maximum TSS (23.80 %) while, highest reducing (18.50 %), non-reducing (1.88 %) and total sugars (20.38 %) was recorded in case of fruits obtained from 15 cm pruned plants. Pal and Ghosh (2019) studied the influence of shoot pruning on reproductive and yield parameters of cv. Balnagar of custard apple. They performed 50 per cent heading back of secondary and tertiary branches during February, March, April, May and June along with control. Plants pruned in the month of May exhibited maximum fruit TSS (21.6 °B), total sugars (19.5 %) and minimum acidity (0.17 %).

Parmar *et al.* (2019) conducted an experiment to analyse the effect of pruning intensities (removal of 25 and 50 % shoot length) along with control plants done during the last week of May on yield and quality attributes of guava cv. Allahabad Safeda. They registered maximum TSS (11.44 °B), total sugars (7.81 %), reducing sugars (5.16 %), non-reducing sugars (2.52 %), ascorbic acid (180.05 mg/100g pulp) and minimum acidity (0.76) in fruits harvested from plants subjected to 25 per cent shoot pruning.

Choudhary *et al.* (2020) investigated the influence of pruning dates on biochemical characteristics of different cultivars of guava. The plants were pruned to 75 per cent of current season growth on different dates *i.e.*, 15th of May, June, July, August and September along with control. They recorded highest TSS (11.43 °B), total sugars (8.04 %) and reducing sugars (4.99 %) in fruits obtained from plants pruned on 15th May whereas, plants pruned on 15th June recorded maximum ascorbic acid (207.68 mg/100 g) and minimum acidity (0.37 %). Singh and Grover (2020) conducted an experiment to ascertain the influence of nodal pruning *viz.*, removal of shoot tip up to 0, 4th, 6th and 8th node in the first week of March on vegetative, reproductive and quality attributes of guava cv. Sardar. They recorded maximum TSS/ Acid ratio (35.79) and ascorbic acid content (203.20 mg/100 g pulp) in fruits obtained from plants pruned up to 8 nodes while, minimum TSS/ acid ratio (31.13) and ascorbic acid (184.70 mg/ 100 g) was recorded in fruits obtained from unpruned plants.

Chapter-3

MATERIAL AND METHODS

The present investigation entitled “**Studies on the effect of pruning intensities and time on winter guava production in cv. Allahabad Safeda under high density planting**” was carried out during the year 2020 and 2021 at the experimental Guava farm of Department of Fruit science, College of Horticulture and Forestry, Neri, Hamirpur. The details of material used and techniques followed during the course of investigation are described below under following heads:

3.1 EXPERIMENTAL SITE

3.1.1 Geographic location

The present study was conducted in the guava block of the experimental farm of Department of Fruit science situated at an elevation of 650 m above mean sea level with coordinates of 31°41'49.98" N latitude and 72°28'02.21" E longitude.

3.1.2 Weather and climate

The region falls under sub-tropical sub-mountain and low hills of Himachal Pradesh. The area is characterized by extremely hot summers during May-June when the temperature may rises up to 40⁰C and severe winters in December-January during which the temperature may drops below 5 ⁰C. Mid- June marks the beginning of the monsoon and continues till the early September. The average annual rainfall of zone ranges from 100-120 cm. The soil type of the study area is sandy loam with pH near neutral.

3.2 EXPERIMENTAL DETAILS

The experiment was laid out in randomized block design with three replications and 2 plants per replication, comprising 18 treatment combinations. Four years old uniformly grown plants of Guava cv. Allahabad Safeda, spaced at 2 m x 2 m were selected for present study. They were kept under uniform condition for orchard management during the study period where all the agronomic practices were carried out as per package of practices. Details of treatments are given below in table 3.1:

Table 3.1 Experimental Details

A. Factors considered	:	2 (Pruning intensities, Time of pruning)
1. Pruning Intensities	:	3
		Shoot pruning of terminal portion up to 10 cm
		Shoot pruning of terminal portion up to 15 cm
		Shoot pruning of terminal portion up to 20 cm
2. Pruning Timings	:	6
		1 st week of May
		3 rd week of May
		1 st week of June
		3 rd week of June
		1 st week of July
		3 rd week of July
B. Cultivar	:	Allahabad Safeda
C. Treatment combinations	:	Pruning intensities x pruning timing
		3 x 6 = 18
D. Number of replications	:	3
E. Plants per replication	:	2
F. Experimental design	:	RBD (Factorial)

3.3 OBSERVATIONS RECORDED

The observations recorded and the methodology adopted for the experiment is being discussed under the following heads and sub-heads:

3.3.1 Vegetative growth parameters

1. Plant height (cm)

The height of the plant was measured with the help of measuring tape from the bottom to the top of the tree. The height was measured twice, one at the time of pruning and second at the time of harvesting of fruits. Increase in the plant height was calculated by subtracting the initial value from the final value and is expressed in centimeters.

2. Trunk girth (cm)

The trunk girth of the plant was measured at 10 cm above the ground level with the help of vernier caliper. The initial trunk girth was measured at the time of



PLATE 1. AN OVERVIEW OF THE EXPERIMENTAL SITE

pruning and the final was measured at the time of harvesting. The increase in the trunk girth was calculated by subtracting the initial value from the final value and is expressed in centimeters.

3. Tree spread (m)

Spread of the tree was measured twice, at the time of pruning and at the time of harvesting in two opposite directions (North- South, East-West) with the help of a measuring tape. The increase in the tree spread was calculated by subtracting the initial value from the final measurement and is expressed in meters.

4. Shoot length (cm)

Four shoots were randomly selected and tagged in four different directions and the length of the newly emerged shoots were measured with the help of measuring tape at the end of the growing season and is expressed in centimeters.

5. Leaf area (cm²)

Twenty fully mature leaves were taken randomly from the plant and the leaf area of the detached leaves was computed with the help of Automatic leaf area meter (CI-202) at end of the growing season. The average leaf area of each treatment was recorded and is expressed in cm².

6. Shoot diameter (cm)

Four shoots in different directions were tagged and measurement was taken twice, at the time of pruning and second after the harvesting of fruits at a specific point marked *i.e.*, 2 cm above from the point of origin of the shoot with the help of Vernier caliper.

7. Trunk cross sectional area (cm²)

The trunk cross sectional area of each tree was calculated using the formula:

$$\text{Trunk Cross Sectional Area} = \pi r^2$$

Where, r = radius

8. Canopy volume (m³)

Volume of the tree canopy was calculated from the height and spread measurements by using the formula given by Westwood (1978) and expressed in m³.

- i) For the trees which were taller than its width $\text{Volume} = 4/3 \pi ab^2$
- ii) For the trees which were wider than its height $\text{Volume} = 4/3 \pi a^2b$

Where, $\pi = 3.1428$

a = 1/2 of major axis (height)

b = 1/2 of minor axis (spread)

3.3.2 Flowering parameters

a) Days for first flower emergence

Average number of days taken for the appearance of first flowering from the date of pruning was recorded.

b) Number of flowers per shoot

Four shoots were randomly selected in each direction and the numbers of flowers per shoot were counted.

c) Fruit set (%)

Four shoots in each direction were labeled and the numbers of flowers on each shoot were counted. Later on, numbers of fruits on each labeled shoot were counted and the fruit set was calculated by the formula given by Westwood (1993).

$$\text{Fruit set (\%)} = \frac{\text{Number of fruits set}}{\text{total number of flowers}} \times 100$$

d) Fruit yield/ plant (kg)

Fruit yield is determined by multiplying the average weight of the fruit with the total number of fruits on each plant and is expressed in kilograms (kg).

3.3.3 Fruit physico- chemical parameters

A. Physical parameters

a) Fruit weight (g)

Five matured fruits obtained from different replications were harvested and weighed with the help of electronic balance and the average value was calculated by taking mean of them. The fruit weight is expressed in grams.

b) Fruit length (cm)

Five matured fruits from different replications were selected and their length was calculated with the help of Vernier caliper and is expressed in cm.



**10 CM SHOOT PRUNING
FROM TIP**



**15 CM SHOOT PRUNING
FROM TIP**



**20 CM SHOOT PRUNING
FROM TIP**

PLATE 2. PLANTS PRUNED AT DIFFERENT PRUNING INTENSITIES

c) Fruit breadth (cm)

Five matured fruits from different replications were selected and their breadth was calculated with the help of Vernier caliper. Measurement was taken from the widest middle point where maximum girth was noticed and is expressed in cm.

d) Fruit volume (cm³)

The volume of five randomly selected fruits in each treatment was measured by water displacement method. A known volume of liquid (V_i) was taken in measuring cylinder and fruit was immersed in it. The volume of liquid displaced (V_f) was noted down and the volume of fruit was calculated by subtracting initial volume from the final volume of water.

According to Mazumdar (2003)

$$V = V_f - V_i$$

Where, V = Fruit volume
 V_i = Initial volume
 V_f = final volume

B) Biochemical characteristics

a) Total soluble solids (⁰B)

The total soluble solids of the fruit were determined with the help of Hand refractometer. The refractometer was calibrated with distilled water before use. The juice from the fruit slices was extracted in a pestle mortar. The drop of the extracted pulp was squeezed on the surface of the prism and the cover slip was placed back. The refractometer reading was taken and the average of reading was calculated for each replication.

b) Titratable Acidity (%)

The titratable acidity was determined by following the procedure suggested by Rangana (1986 a). 10 g of fruit sample was taken, diluted with distilled water and the final volume was made to 100 ml. 10 ml of this extract was titrated against 0.1 N NaOH solution using phenolphthalein as an indicator until it gave pink coloured end point. The acidity was calculated by using formula:

$$\text{acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of NaOH} \times \text{Volume made} \times \text{equivalent weight of acid}}{\text{volume of sample for estimation} \times \text{volume of aliquot taken} \times 1000} \times 100$$

c) Ascorbic acid content (mg/ 100g)

The Ascorbic acid content was determined by the procedure suggested by Rangana (1986 b). Ten grams of the pulp was transferred in 100 ml volumetric flask and the final volume was made up 100 ml with 3 % metaphosphoric acid solution. The solution was filtered through whatman No. 1 filter paper. Before the actual titration, the 2,6- dichlorophenol indophenol dye solution was standardized by titrating against standard solution of concentrated ascorbic acid and the dye factor was calculated. 5 ml of aliquot was taken from the filtrate and titrated against standardized dye solution till the light pink color appeared. The color should persist for atleast 15 seconds. Ascorbic acid content was calculated by using the following formula.

$$\text{Ascorbic acid (mg/100g)} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume made up} \times 100}{\text{Volume of aliquot of extract} \times \text{Volume of sample taken}}$$

d) Reducing sugars (%)

The reducing sugar was measured by following the procedure suggested by Rangana (1986). 25 g of sample was weighed down. Then 100 ml of distilled water was added and neutralized with 1 N NaOH. 2 ml of lead acetate solution (45 %) was added and allowed to stand for 10 minutes. Then 2 ml of Potassium oxalate was added and the final volume was made to 250 ml with addition of distilled water. It was filtered and filtrate was collected (Filtrate A solution). Out of this 100 ml was kept for determination of total sugars. To determine reducing sugars 5 ml of both Fehling A and Fehling B solution was taken. 50 ml of distilled water was added to it and mixed well. Solution was boiled on the hot plate and 2-3 drops of methylene blue was added. The boiling solution was titrated against the Filtrate A solution, till the appearance of brick red color/ precipitates (end point). The results were expressed as percent of reducing sugar.

$$\text{Reducing Sugar (\%)} = \frac{\text{Factor} \times \text{Dilution}}{\text{weight of sample} \times \text{Titre Value}} \times 10$$

e) Total sugars (%)

An aliquot of 25 ml from the remaining 100 ml of clarified solution kept of estimation of total sugars was taken and was hydrolyzed by adding 5 ml of concentrated HCl. The sample was left for inversion for 24 hours at room temperature. The excess of HCl was then neutralized with 1.0 N NaOH and the final

volume was made up to 100 ml. The total sugar was estimated by titrating the boiling mixture containing 5 ml each of Fehling A and B solution with the sample using methylene blue as an indicator, till the appearance of brick red colour. The values were expressed in percent on fresh pulp weight basis.

$$\text{Total sugars (\%)} = \frac{\text{Factor X Dilution made X Final volume made}}{\text{Weight of sample taken} \times \text{Volume of sugar taken in reducing sugar} \times \text{Titre value}} \times 100$$

f) **Non-reducing sugars (%)**

Non-reducing sugar was calculated as suggested by Rangana (1986c). The value of non-reducing sugar was calculated by subtracting reducing sugar from the total sugar and multiplied with 0.95(AOAC, 1980).

$$\text{Non reducing sugar} = (\% \text{ total invert sugar} - \% \text{ reducing sugar}) \times 0.95$$

g) **TSS: acid ratio:** It was calculated by dividing total soluble solids by total titratable acidity.

3.4 Statistical Analysis

The data generated from these investigations were appropriately computed, tabulated and analyzed by using MS-Excel and OPSTAT. The data values were subjected to variance analysis as procedure outlined by Gomez and Gomez (1984) for Randomized Block Design.

ANOVA for RBD factorial

	Degree of freedom	Sum of squares	Mean sum of squares	F _{cal}
Replication	(r-1)	SSr	MSr=SSr/(r-1)	MSr/MSe
Treatments (a)	(a-1)	SSa	MSa= SSa/(a-1)	MSa/MSe
Time (b)	(b-1)	SSb	MSb= SSb/(b-1)	MSb/MSe
Treatment x time (A×B)	(a-1) (b-1)	SSab	MSab=SSab/(a-1)(b-1)	MSab/MSe
Error	(r-1)(ab-1)	ESS	MSE=ESS/(r-1)(ab-1)	
Total	(rab-1)			

Where,

- a= Pruning intensity
- r = No. of replications
- b= Time

The mean sum of square due to main effect and interaction was tested against error mean squares by 'F' test at 5% level of significance. When F- test was found significant ($F_{cal} > F_{tab}$), critical difference was calculated to pair wise comparison of treatments.

Critical difference (CD) was calculated as follows:

The standard error and critical difference was calculated as follow:

	Pruning intensity	Time	Pruning intensity x time
SE (d)	$\sqrt{\frac{2 \times M_e}{ra}}$	$\sqrt{\frac{2 \times M_e}{rb}}$	$\sqrt{\frac{2 \times M_e}{r}}$
CD_{0.05}	$\sqrt{\frac{2 \times M_e}{ra}} \times p_{(0.05)(r-1)(ab-1)}$	$\sqrt{\frac{2 \times M_e}{rb}} \times p_{(0.05)(r-1)(ab-1)}$	$\sqrt{\frac{2 \times M_e}{r}} \times p_{(0.05)(r-1)(ab-1)}$

Chapter-4

RESULTS AND DISCUSSION

The present investigations entitled “**Studies on the effect of pruning intensities and time on winter guava production in cv. Allahabad Safeda under high density planting**” were carried out during the year 2020 and 2021 at the experimental guava farm of Department of Fruit Science, College of Horticulture and Forestry, Neri, Hamirpur. The results, thus obtained are presented, discussed and supported with relevant references under the following heads:

4.1 Effect of pruning intensity and time on vegetative growth characteristics

The effect of pruning intensities, pruning time and their interactions on plant growth attributes exhibited a significant outcome and are presented here in different Tables.

4.1.1 Plant height

The data pertaining to the effect of pruning intensity and time of pruning on plant height is presented in Table 4.1. It is evident from the data that irrespective of the time of pruning, the pruning intensity exhibited a significant influence on plant height. The maximum increase in plant height (53.55 cm) was observed in the plants which were shoot pruned to 10 cm from the top (P_1) followed by treatment P_2 (49.47 cm) while, minimum increase in plant height (47.91 cm) was recorded in guava plants which were headed back to 20 cm from the top.

Among different pruning times, maximum increase in plant height (56.00 cm) was found in plants which were pruned during 1st week of May (T_1) which was found to be statistically at par with T_2 (54.05 cm) whereas, minimum increase in plant height (44.16 cm) was observed in plants which were pruned on 3rd week of July (T_6).

The interaction between pruning intensity and time of pruning ($P \times T$) was found highly significant. The plants which were pruned to 10 cm from the top of the shoot during the 1st week of May exhibited maximum increase in plant height (61.16 cm) which was found statistically at par with treatment combination P_1T_2 (58.33 cm).

However, minimum increase in plant height (40.00 cm) was noticed in the plants those were pruned to 20 cm from the shoot tip in the 3rd week of July.

It is evident from the data that early pruning resulted in more plant growth as compared to pruning executed later. Similar results were obtained by Basu *et al.* (2007) and Choudhary *et al.* (2020) in guava. The probable reason for higher incremental growth in early pruned plants might be due to availability of longer growing period. Pruning severity had a significant impact on plant height. With the increase in the level of pruning severity the increase in plant height was less. Their results are in line with the findings of Kumar and Rattanpal (2010) who stated that severely pruned plants are unable to make up the loss of the growth in short period of time as compared to lightly pruned plants. Similar results were reported by Mahesh *et al.* (2016) in guava cv. Sardar.

Table 4.1 Effect of pruning intensity and time of pruning on plant height and leaf area in guava.

Pruning treatments	Increase in plant height (cm)				Leaf area (cm ²)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T₁: 1st week of May	61.16	54.16	52.66	56.00	61.17	63.95	68.58	64.57
T₂: 3rd week of May	58.33	52.83	51.00	54.05	57.96	58.68	64.71	60.45
T₃: 1st week of June	53.50	51.83	48.66	51.33	54.82	56.81	59.61	57.08
T₄: 3rd week of June	52.00	46.16	49.66	49.27	54.29	55.71	57.35	55.79
T₅: 1st week of July	48.50	47.16	45.50	47.05	51.11	52.66	54.16	52.64
T₆: 3rd week of July	47.83	44.66	40.00	44.16	48.60	49.04	50.70	49.44
Mean	53.55	49.47	47.91		54.66	56.14	59.19	
CD_{0.05}	P: 1.48				P: 1.34			
	T: 2.09				T: 1.90			
	P X T: 3.62				P X T: NS			

4.1.2 Leaf area

Perusal of data given in Table 4.1 reveals that among the different pruning intensities the maximum leaf area (59.19 cm²) was recorded by the guava plants which were severely pruned (P₃) followed by moderately pruned plants (56.14 cm²)

while, minimum leaf area (54.66 cm²) was produced by the plants which were lightly pruned (P₁).

Irrespective of the pruning intensity, pruning time had a significant effect on the leaf area. Maximum leaf area (64.57 cm²) was recorded by the plants which were pruned during 1st week of May (T₁) followed by T₂ (60.45 cm²). However, minimum leaf area (49.44 cm²) was observed in the plants which were pruned during 3rd week of July (T₆).

However, the interaction between pruning intensity and time of pruning (P × T) had a non- significant effect on the leaf area.

It can be inferred from the present investigation that earliest pruned plants recorded maximum leaf area. This might be due to more availability of growing period in early pruned plants as compared to lately pruned plants. However, with the increase in pruning severity leaf area also increased. This probably is due to more uptake of nutrients from the soil and their accumulation in leaf tissues which ultimately enhances the leaf area (Dahupute *et al.*, 2020). The results are parallel with the findings of Adhikari and Kandel (2010) in guava, Piloni *et al.* (2010) in guava, Dahupute *et al.* (2018) in custard apple and Bhuvra *et al.* (2018) in pomegranate. In severely pruned plants there is a reduction in number of shoots per branch and increased shoot length which ultimately results in more availability of nutrients to the growing shoots and leaves (Gopikrishna, 1997).

4.1.3 Canopy spread

4.1.3.1 East- West direction

The data presented in the Table 4.2 depicted that irrespective of the time of pruning, pruning intensity exerted a significant effect on plant canopy spread in E-W direction. The maximum increase (0.51 m) in canopy spread in E-W direction was recorded in plants which were pruned to 10 cm from the shoot tip (P₁) whereas, minimum increase (0.46 m) in canopy spread in E-W direction was noticed in the plants which were severely pruned (P₃).

The canopy spread in E-W direction in plants pruned at different timings exhibited a remarkable effect. The maximum increase in canopy spread in E-W direction (0.54 m) was recorded in the plants which were pruned in the 1st week of May, which was found to be statistically similar to T₂ (0.52 m). However, minimum increase in canopy spread (0.40 m) in E-W direction was recorded in the plants pruned in the 3rd week of July (T₆).

The interaction between pruning intensity and time of pruning (P x T) on plant canopy spread in E-W direction had non- significant effect.

Table 4.2 Effect of pruning intensity and time of pruning on plant canopy spread in guava.

Pruning treatments	Increase in E-W direction (m)				Increase in N-S direction (m)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	0.56	0.54	0.53	0.54	0.55	0.51	0.50	0.52
T ₂ : 3 rd week of May	0.54	0.52	0.49	0.52	0.53	0.51	0.49	0.51
T ₃ : 1 st week of June	0.52	0.51	0.49	0.51	0.50	0.49	0.45	0.48
T ₄ : 3 rd week of June	0.51	0.49	0.46	0.48	0.48	0.47	0.45	0.47
T ₅ : 1 st week of July	0.48	0.47	0.44	0.46	0.46	0.44	0.43	0.44
T ₆ : 3 rd week of July	0.44	0.38	0.37	0.40	0.44	0.42	0.41	0.42
Mean	0.51	0.48	0.46		0.49	0.47	0.46	
CD _{0.05}	P: 0.01 T: 0.02 P X T: NS				P: 0.02 T: 0.01 P X T: NS			

4.1.3.2 North- South direction

Data enumerated in Table 4.2 revealed that pruning intensity had a significant impact on plant canopy spread in N-S direction. The maximum increase in plant canopy spread in N-S direction (0.49 m) was found in plants which were pruned to 10 cm from the shoot tip, which was found statistically at par with treatment P₂ (0.47 m). However, minimum increase in canopy spread in N-S direction (0.46 m) was observed in plants those were pruned to 20 cm from the shoot tip.

The data pertaining to the effect of pruning time on plant canopy spread in N-S direction depicted that plants pruned during 1st week of May induced maximum increase in canopy spread in N-S direction (0.52 m) which was statistically similar with treatment T₂ (0.51 m) while, minimum increase in plant canopy spread (0.42 m) was exhibited by plants pruned during 3rd week of July.

It is also evident from the data in the given Table that the interaction between pruning intensity and time of pruning (P×T) on plant canopy spread in N-S direction has found non-significant effect.

During the present investigation, it was observed that mild pruning intensity (10 cm pruning from the shoot tip) resulted in maximum increase in canopy spread in E-W and N-S direction. The results are in conformity with the findings of Lian *et al.* (2019), Harshitha *et al.* (2019) and Kumar and Rattanpal (2010) in guava who opined that decrease in the canopy spread with increased pruning severity might be due to the fact that severely pruned plants are unable to cope up with the growth loss in short span of time. These findings corroborate with the observations of Sundarajan and Muthuswamy (1966) who stated that mild pruning by tipping increases numbers of functionary laterals in guava which results in more canopy spreading. The present data clearly states that among the different pruning times the earliest summer pruning resulted in maximum increase in plant canopy spread. The probable reason for higher incremental growth in early summer pruned plants might be due to reduced competition for photosynthates and availability of longer growing period.

4.1.4 Shoot length

A cursory glance of the data presented in Table 4.3 revealed that pruning intensities and time of pruning had a significant effect on shoot length. Among different pruning intensities, maximum shoot length (34.27 cm) was observed in severely pruned plants followed by moderately pruned plants (32.15 cm). However, minimum shoot length (30.66 cm) was produced in lightly pruned plants (P₁).

With respect to time of pruning, maximum shoot length (42.62 cm) was found in plants pruned during 1st week of May (T₁) followed by plants pruned during 3rd

week of May (36.34 cm) while, minimum shoot length (25.52 cm) was observed in plants pruned during 3rd week of July (T₆).

From the above data it is clear that the interaction between pruning intensity and time of pruning (P×T) on new shoot length was found significant. The maximum shoot length (47.11 cm) was exerted in plants subjected to 20 cm shoot pruning during 1st week of May followed by T₁P₂ (43.07 cm). However, minimum shoot length (24.99 cm) was induced in lightly pruned plants during 3rd week of July (P₁T₆) which was found statistically at par with P₂T₆ (25.52 cm), P₃ T₆ (26.04 cm), P₁T₅ (26.87 cm), P₂ T₅ (27.51 cm).

It is inferred from the present study that early pruned plants exerted maximum shoot length. Ferree *et al.* (1984) reported that the early summer pruning increased the shoot re-growth, owing to the increased level of cytokinins and other growth hormones which triggers the vegetative growth faster. It can be visualized from the data that shoot length showed an increasing trend with the increase in pruning severity. The result was found to be in accordance with the findings of Bhagwati *et al.* (2015), Kumar *et al.* (2017), Samant *et al.* (2016) and Kumar *et al.* (2021) in guava. Bhagwati *et al.* (2016) opined that the increase in shoot length with the pruning severity might be due to comparatively less number of shoots and more availability of nutrients per shoot. Severity of pruning increases the shoot length due to the quick response of the supply of reserved food material absorbed by the roots and transmission of the same to the main trunk (Shiranal, 2015). Similar results were reported by Shaban and Haseeb (2009) in guava.

4.1.5 Shoot diameter

It is inferred from the data presented in Table 4.3 that pruning intensity had a significant impact on shoot diameter. The maximum increase in shoot diameter (0.78 cm) was observed in lightly pruned plants (P₁) which was found statistically at par with treatment P₂ (0.75 cm) whereas, minimum increase in shoot diameter (0.73 cm) was recorded in severely pruned guava plants (P₃).

Table 4.3 Effect of pruning intensity and time of pruning on shoot length and shoot diameter in guava.

Pruning treatments	Shoot length (cm)				Increase in shoot diameter (cm)			
	P ₁ 10 cm	P ₂ 15cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	37.68	43.07	47.11	42.62	1.07	0.99	0.90	0.99
T ₂ : 3 rd week of May	34.72	35.81	38.48	36.34	0.87	0.84	0.84	0.85
T ₃ : 1 st week of June	30.87	31.63	33.53	32.01	0.83	0.82	0.79	0.81
T ₄ : 3 rd week of June	28.80	29.34	31.42	29.85	0.74	0.72	0.70	0.72
T ₅ : 1 st week of July	26.87	27.51	29.07	27.82	0.65	0.64	0.63	0.64
T ₆ : 3 rd week of July	24.99	25.52	26.04	25.52	0.52	0.51	0.55	0.53
Mean	30.66	32.15	34.27		0.78	0.75	0.73	
CD_{0.05}	P: 1.17 T: 1.66 P X T: 2.88				P: 0.03 T: 0.04 P X T: NS			

Among the different pruning times, maximum increase in shoot diameter (0.99 cm) was observed in plants pruned in the 1st week of May followed by T₂ (0.85 cm) whereas, minimum increase in shoot diameter (0.53 cm) was found in the plants pruned during 3rd week July (T₆). The interaction between pruning intensity and time of pruning (P×T) had a non-significant effect on the shoot diameter.

The above data revealed that the maximum increase in shoot diameter was found in lightly pruned plants as compared to severely pruned plants. The present findings are in close conformity with Solanki *et al.* (2016) in mango and Purnima J. (2016) in guava. This could be due to the fact that lightly pruned plants have more amounts of nutrients and reserved food material stored whereas, in severely pruned plants a part of energy is always utilized in wound healing process (Purnima J. 2016). Moreover, in severely pruned plants nutrients are utilized in new shoot growth, whereas in lightly pruned trees there is less shoot growth and more accumulation of food material and nutrients.

4.1.6 Trunk girth

It is evident from the data presented in Table 4.4 that pruning intensity had a significant effect on increase in trunk girth. The mild pruning intensity (10 cm

pruning from the shoot tip) resulted in maximum increase in trunk girth (2.37 cm) followed by moderately pruned plants (2.33 cm) whereas, minimum increase in trunk girth (2.31 cm) was induced by 20 cm shoot pruning from the tip (P₃).

With respect to the effect of pruning time on trunk girth, maximum increase in trunk girth (2.47 cm) was recorded in plants pruned during 1st week of May (T₁) followed by treatment T₂ (2.43 cm) while, minimum increase in trunk girth (2.15 cm) was recorded in plants pruned during 3rd week of July (T₆).

The interaction between pruning intensity and time of pruning (P×T) was also found significant with respect to the trunk girth. Maximum increase in trunk girth (2.55 cm) was observed in the plants which were pruned to 10 cm from the shoot tip during 1st week of May followed by P₁T₂ (2.46 cm). However, minimum increase in trunk girth (2.09 cm) was recorded in the plants those were pruned to 20 cm from the tip during 3rd week of July (P₃T₆).

Table 4.4 Effect of pruning intensity and time of pruning on trunk girth in guava.

Pruning treatments	Increase in trunk girth (cm)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	2.55	2.44	2.44	2.47
T ₂ : 3 rd week of May	2.46	2.41	2.40	2.43
T ₃ : 1 st week of June	2.41	2.37	2.36	2.38
T ₄ : 3 rd week of June	2.34	2.32	2.31	2.32
T ₅ : 1 st week of July	2.30	2.27	2.25	2.27
T ₆ : 3 rd week of July	2.19	2.18	2.09	2.15
Mean	2.37	2.33	2.31	
CD _{0.05}	P: 0.01 T: 0.02 P X T: 0.04			

It is obvious from the data presented here that increase in trunk girth decreased with the increase in pruning intensity and delay in pruning time. The present findings are in accordance with results of Lian *et al.* (2016) and Meena *et al.* (2017) in guava who, opined that the early pruning increases trunk girth than late pruning. This might

be due the shift of metabolites from rainy season flowering towards the new vegetative growth resulting in increase in trunk girth.

4.1.7 Canopy volume

The perusal of data given in Table 4.5 demonstrated that effect of pruning intensity on plant canopy volume was found non- significant. However, maximum canopy volume (2.40 m³) was observed in plants pruned to 10 cm from the shoot apex followed by plants pruned to 20 cm from the shoot tip (2.37 m³).

Among the different pruning times, guava plants pruned during 1st week of May (T₁) resulted in maximum canopy volume (2.95 m³) which was found statistically similar with treatment T₂ (2.91 m³) whereas, minimum plant canopy volume (1.86 m³) was found in plants pruned during 1st week of July which was found statistically at par with treatment T₄ (2.31 m³) and T₆ (1.87 m³).

Table 4.5 Effect of pruning intensity and time of pruning on canopy volume and TSCA in guava.

Pruning treatments	Canopy volume (m ³)				TCSA (cm ²)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T₁: 1st week of May	3.40	2.86	2.59	2.95	29.30	28.32	29.97	29.20
T₂: 3rd week of May	2.82	2.99	2.91	2.91	29.28	28.23	26.97	28.16
T₃: 1st week of June	2.66	2.14	2.01	2.27	27.18	27.24	29.34	27.92
T₄: 3rd week of June	2.10	2.22	2.61	2.31	26.10	26.62	24.59	25.77
T₅: 1st week of July	1.76	1.76	2.07	1.86	25.82	25.58	25.41	25.61
T₆: 3rd week of July	1.67	1.93	1.99	1.87	24.54	25.20	23.31	24.35
Mean	2.40	2.32	2.37		27.04	26.86	26.60	
CD_{0.05}	P: NS T: 0.04 P X T: NS				P: NS T: 2.06 P X T: NS			

However, the interaction between pruning intensity and time of pruning was found non- significant on canopy volume. Maximum canopy volume (3.40 m³) was observed in plants pruned to 10 cm from shoot tip during 1st week of May (P₁T₁).

The increase in canopy volume with the mild pruning intensity was also reported by Kumar and Rattanpal (2010), Purnima J. (2016) in guava, Singh *et al.* 2009 in mango and Dahupute *et al.* (2020) in custard apple. Severely pruned plants are unable to make up for the loss in a short period of time as compared to lightly pruned plants (Kumar and Rattanpal, 2010). Dahupute *et al.* (2018) stated that highest canopy volume in early pruned plants is probably due to better availability of sunlight, water and other nutrients which resulted in increased photosynthetic activity that have resulted into better canopy volume.

4.1.8 Trunk cross-sectional area

A critical examination of data pertaining to trunk cross sectional area is presented in Table 4.5 which revealed that pruning intensities had a non-significant effect on TCSA. Maximum trunk cross sectional area (27.04 cm²) was recorded in lightly pruned plants (P₁) while, minimum TCSA (26.60 cm²) was observed in plants pruned to 20 cm from the shoot tip (P₃).

Trunk cross sectional area showed a significant effect at different pruning times. Maximum trunk- cross sectional area (29.20 cm²) was observed in plants pruned on 1st week of May followed by treatment T₂ (28.16 cm²). However, minimum trunk cross-sectional area (24.35 cm²) was recorded in plants pruned during 3rd week of July which was found statistically at par with T₅ (25.61 cm²) and T₄ (25.77 cm²).

However, the interaction between pruning intensity and pruning time (P X T) was found non- significant.

4.2 Effect of pruning intensity and time of pruning on reproductive growth characteristics of guava

4.2.1 Days taken for first flower emergence

Data highlighted in the Table 4.6 indicated that pruning intensity had a significant effect on flower emergence. The minimum time for flower emergence (43.22 days) was taken by plants pruned to 10 cm from the shoot tip followed by P₂ (44.08 days) while, maximum time (44.80 days) was taken by plants subjected to 20 cm shoot pruning from apex (P₃).

The time of pruning also exhibited significant effect on flower emergence. Minimum time for flower emergence (39.38 days) was taken by plants pruned during 1st week of May (T₁) followed by plants pruned during 3rd week of May (T₂) (41.88 days) whereas, maximum time for flower emergence (47.72 days) was taken by plants which were pruned during 3rd week of July (T₆).

The interaction between pruning intensity and time of pruning (P×T) on days taken for flower emergence was also found significant. Earliest flower emergence (38.16 days) was observed in the plants which were pruned to 10 cm from shoot tip on 1st week of May, which was found statistically at par with treatment combination P₂T₁ (39.00 days) while, maximum time for flower emergence (48.33 days) was recorded in plants pruned to 20 cm from shoot tip during 3rd week of July, which was statistically similar with P₂T₆ (47.50 days) and P₁T₆ (47.33 days) respectively.

Table 4.6 Effect of pruning intensity and time of pruning on days for flower emergence and number of flowers/ shoots in guava.

Pruning treatments	Days for first flower emergence				Number of flowers/ shoots			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	38.16	39.00	41.00	39.38	7.42	7.04	6.67	7.04
T ₂ : 3 rd week of May	40.33	42.50	42.83	41.88	6.38	6.29	5.88	6.18
T ₃ : 1 st week of June	43.00	43.83	44.16	43.66	5.67	5.38	4.83	5.29
T ₄ : 3 rd week of June	44.50	45.16	45.66	45.11	4.63	4.50	4.33	4.49
T ₅ : 1 st week of July	46.00	46.50	46.83	46.44	4.33	4.25	3.83	4.14
T ₆ : 3 rd week of July	47.33	47.50	48.33	47.72	3.88	3.67	3.33	3.63
Mean	43.22	44.08	44.80		5.38	5.19	4.81	
CD _{0.05}	P: 0.42 T: 0.60 P X T: 1.04				P: 0.25 T: 0.35 P X T: NS			

It is evident from the above data that the early and light pruning took comparatively less time for flower emergence than severely pruned plants. The data were in conformity with the findings of Purnima J. (2016) and Adhikari and Kandel (2015) in guava. Earliest flower emergence in early pruned plants might be due to the early start of new vegetative growth which ultimately induced early flowering

(Adhikari and Kandel, 2015). Meena *et al.* (2017) concluded that the early flowering in May pruning might be due the rise in temperature during the period of growth which favored early flowering. Moreover, in severely pruned plants almost a major amount of carbohydrates and nutrients are utilized in wound healing process which results in the late start of flowering as compared to lightly pruned plants.

4.2.2 Number of flowers per shoot

The critical examination of data pertaining to the effect of pruning intensity and time of pruning on number flowers per shoot is presented in Table 4.6. The data demonstrated that maximum number of flowers per shoot (5.38) were produced by lightly pruned plants (P_1) which was statistically at par with treatment P_2 (5.19) whereas, minimum number of flowers per shoot (4.81) were observed in severely pruned plants (P_3).

Among different pruning times, highest number of flowers per shoot (7.04) was recorded in plants pruned during 1st week of May (T_1) followed by treatment T_2 (6.18) while, least number of flowers per shoot (3.63) were observed in plants pruned during 3rd week of July (T_6).

However, the interaction between pruning intensity and time of pruning ($P \times T$) on number of flowers per shoot was found non- significant.

Severe pruning had much adverse effect on flowering than mild pruning. Reduction in number of flowers in severely pruned branches might be due to loss of potential flower bearing area. This might be the reason for increased number of flowers in lightly pruned branches. Samant *et al.* (2016) stated that with the increase in pruning severity there is reduction in plant biomass resulting in decreased C: N ratio which ultimately leads to more shoot growth and less flowering. The results of present finding are in close conformity with the finding of Jadhav *et al.* (2002) in guava and Mohamed (2010) in custard apple. The increase in number of flowers with early pruning (May) might be due to the prevalence of optimum temperature and better light distribution inside the plant canopy which increased the flower production on new shoot growth (Singh *et al.*, 2001).



FLOWER INITIATION



FLOWER OPENING



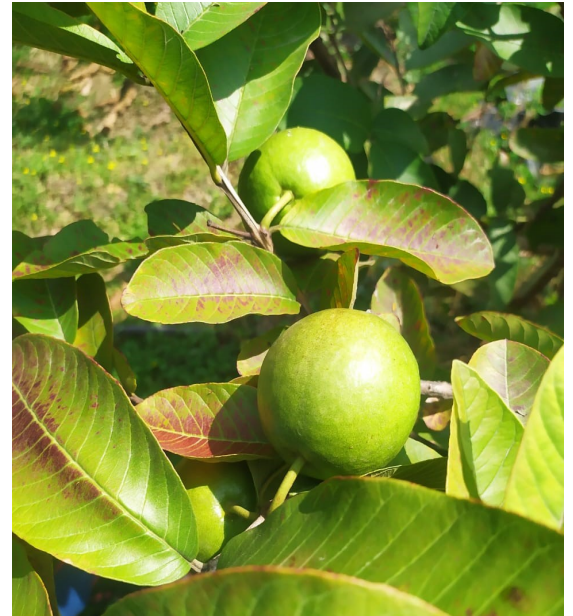
FLOWERING



PETAL FALL



FRUIT SET



DEVELOPING FRUITS

PLATE 3. DIFFERENT PHENOLOGICAL STAGES IN GUAVA

4.2.3 Fruit set

Data enumerated in Table 4.7 revealed that pruning intensity and time of pruning had affected the fruit set significantly. The highest fruit set (32.24 %) was recorded in plants which were subjected to 10 cm pruning from tip (P_1) followed by P_2 (29.93 %) while, plants pruned to 20 cm from the shoot tip exhibited lowest fruit set (28.84 %).

The fruit set differ significantly with pruning time. Highest fruit set (40.95 %) was observed in plants pruned during 1st week of May (T_1) followed by T_2 (35.61 %) while, lowest fruit set (21.93 %) was recorded in plants pruned during 3rd week of July (T_6).

The interaction effect of pruning intensity and time of pruning was found significant with respect to the fruit set. Plants pruned to 10 cm pruning from the shoot tip during 1st week of May resulted in highest fruit set (43.73 %) which was found statistically at par with treatment P_2T_1 (40.73 %) whereas, lowest fruit set (20.60 %) was recorded in plants shoot pruned to 20 cm from the shoot tip during 3rd week of July which was statistically at par with treatment combination P_2T_6 (22.38 %) and P_1T_6 (22.80 %).

The investigation revealed that with delayed pruning and increase in pruning severity fruit set decreased. The results were in close agreement with the findings of Balmohan and Kala (2019) in guava, Singh *et al.* (2020) in guava cv. Allahabad Safeda and Choudhary and Dhakare in custard apple. Balmohan further opined that probable reason for poor fruit set in severely pruned plants is due to removal of potential food synthesizing young shoots and lesser availability of nutrients. Summer pruning performed during the early part of the year resulted in maximum fruit set and fruit yield, which might be due to the improved flowering, increased leaf area, leaf photosynthetic activity and more nutrient availability (Miller 1982).

4.2.4 Fruit yield

A cursory view of data presented in Table 4.7 revealed that pruning intensity and time of pruning had a significant effect on fruit yield. Among the different pruning intensities, maximum fruit yield (7.29 kg/ tree) was recorded in plants

subjected to 10 cm shoot pruning from the terminal portion (P₁) while, minimum fruit yield (7.00 kg/ tree) was observed in plants pruned to 20 cm (P₃) which was statistically similar with plants subjected to 15 cm shoot pruning from the shoot apex (7.04 kg/tree).

Table 4.7 Effect of pruning intensity and time of pruning on fruit set and fruit yield in guava.

Pruning treatments	Fruit set (%)				Fruit yield (kg/ plant)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T₁: 1st week of May	43.73 (41.37)	40.73 (39.63)	38.38 (38.26)	40.95 (39.76)	8.80	8.01	7.96	8.26
T₂: 3rd week of May	39.59 (38.96)	34.07 (35.67)	33.18 (35.15)	35.61 (36.60)	7.50	7.37	7.45	7.44
T₃: 1st week of June	31.71 (34.25)	31.09 (33.86)	30.58 (33.55)	31.12 (33.89)	7.23	7.16	7.14	7.18
T₄: 3rd week of June	27.80 (31.80)	27.30 (31.48)	26.57 (31.00)	27.22 (31.43)	6.98	6.90	6.75	6.87
T₅: 1st week of July	27.83 (31.81)	24.02 (29.32)	23.74 (29.14)	25.19 (30.09)	6.80	6.47	6.49	6.59
T₆: 3rd week of July	22.80 (28.51)	22.38 (28.20)	20.60 (26.97)	21.93 (27.89)	6.45	6.32	6.23	6.33
Mean	32.24 (34.45)	29.93 (33.03)	28.84 (32.35)		7.29	7.04	7.00	
CD_{0.05}	P: 0.87				P: 0.13			
	T: 1.23				T: 0.18			
	P X T: 2.13				P X T: 0.32			

**Figures in parentheses are the angular transformed values.*

Similarly, time of pruning also had a remarkable effect on fruit yield. The maximum fruit yield (8.26 kg/ tree) was observed in plants pruned during 1st week of May followed by 3rd week shoot pruning (7.44 kg/tree). However, minimum fruit yield (6.33 kg/tree) was recorded in plants pruned during 3rd week of July.

It is also evident from the data in Table that the interaction between pruning intensity and pruning time showed significant variation with respect to the fruit yield. Highest fruit yield (8.80 kg/ tree) was recorded in plants pruned to 10 cm from the shoot tip during 1st week of May followed by P₂T₁ (8.01 kg/tree) while, minimum fruit yield (6.23 kg/ tree) was observed in plants pruned to 20 cm from the shoot apex during 3rd week of July.



**Fruit yield with 10 cm shoot
pruning from tip in first week of May
(P₁T₁)**



**Fruit yield with 15 cm shoot
pruning from tip in first week of May
(P₂T₁)**



**Fruit yield with 20 cm shoot
pruning from tip in first week of May
(P₃T₁)**

PLATE 4. FRUIT PRODUCTION UNDER DIFFERENT PRUNING INTENSITIES

The results of the present study are in close agreement with Brar *et al.* (2004) and Sahar *et al.* (2014) in guava. They recorded maximum fruit yield with light pruning intensity performed during May. The probable reason of reduction of fruit yield in severest pruning might be the lower number of flower bud and reduced fruit bearing area. Singh *et al.* (2020) reported that the increase in fruit yield of guava with light pruning might be due to the production of large number of flowering shoots, diversion of stored materials for production of healthy shoots, profuse flowering and higher fruit set. The results were in consonance with the results of Adhikari and Kandel (2015), Awasthy and Arumugam (2017) in guava. Highest fruit yield in early pruned trees is due to the removal of the growing shoots thereby, reducing the crop load during rainy season and subsequently shifting the metabolites towards the production of winter season crop (Singh, 2019). Highest fruit production in May-pruned shoots probably due to newer shoot growth on which the flowering and fruiting initiated and coincided with the natural rain resulting in better availability of moisture and nutrients (Pal and Ghosh, 2019).

4.3 Quality attributes

4.3.1 Physical characteristics

4.3.1.1 Fruit weight

The data regarding the effect of pruning intensities, pruning time and their interactions is demonstrated in Table 4.8. It is evident from the data that irrespective of the time of pruning, pruning intensity had a significant effect on fruit weight. The maximum fruit weight (145.49 g) is recorded in fruit obtained from plants subjected to 20 cm shoot pruning from the terminal portion (P_1) followed by 15 cm shoot pruning (141.63 g). However, minimum fruit weight (138.18 g) was recorded in fruits obtained from plants subjected to 10 cm shoot pruning from the tip.

Significant influence of pruning time on fruit weight was also observed. Among different pruning times, plants pruned during 1st week of May produced fruits with maximum fruit weight (150.60 g) which was found statistically at par with treatment T_2 (148.39 g) whereas, minimum fruit weight (125.79 g) was recorded in fruits produced from plants pruned during 3rd week of July.

The results revealed that interaction between pruning intensity and pruning time ($P \times T$) was also found significant with respect to fruit weight. The maximum fruit weight (156.12 g) was found in the fruits received from severely pruned plants during 1st week of May followed by fruits picked from plants subjected to 20 cm shoot pruning from the apex during 3rd week of May (150.91 g).

It is evident from the present investigation that severely pruned plants resulted in more fruit weight than lightly pruned plants. This might be attributed to the fact that with the increase in pruning intensity number of fruits per plant decreases due to which the developing fruits gets ample of nutrients and photosynthates resulting in higher fruit weight (Sahoo *et al.* 2017). The results are in accordance with the findings of Singh *et al.* (2020) and Bhagwati *et al.* (2015) in guava. Ali *et al.* (2014) found maximum fruit weight in severely pruned plants during May. Likewise, Shinde *et al.* (2020) recorded highest fruit weight in severely pruned plants during 1st week of May. Increased pruning severity resulted in better source-sink relationship and reduced competition for photo-assimilates among the fruits which resulted in increase of fruit weight and fruit size (Gill and Bal, 2006).

Table 4.8 Effect of pruning intensity and time of pruning on fruit weight and fruit volume in guava.

Pruning treatments	Fruit weight (g)				Fruit volume (cm ³)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	147.38	148.29	156.12	150.60	156.72	157.54	162.01	158.76
T ₂ : 3 rd week of May	145.47	148.80	150.91	148.39	155.95	156.95	157.64	156.84
T ₃ : 1 st week of June	141.26	142.17	146.00	143.14	151.15	153.98	154.98	153.37
T ₄ : 3 rd week of June	139.58	140.98	144.90	141.82	147.61	148.80	151.25	149.22
T ₅ : 1 st week of July	140.29	140.89	141.39	140.86	142.86	145.58	146.41	144.95
T ₆ : 3 rd week of July	115.10	128.63	133.64	125.79	136.51	137.56	139.18	137.75
Mean	138.18	141.63	145.49		148.47	150.07	151.91	
CD_{0.05}	P: 2.29				P: 1.89			
	T: 3.23				T: 2.67			
	P X T: 5.60				P X T: NS			

4.3.1.2 Fruit volume

Data regarding the influence of pruning intensity and pruning time on fruit volume was presented in Table 4.8. The maximum fruit volume among the different pruning intensities were observed in treatment P₃ (151.91 cm³) which was statistically at par with treatment P₂ (150.07 cm³).

The values shown in the Table further revealed that among different pruning times, plants pruned during 1st week of May resulted in highest fruit volume (158.76 cm³) which was statistically at par with treatment T₂ (156.84 cm³) while, minimum fruit volume (137.75 cm³) was observed in fruits harvested from plants pruned during 3rd week of July.

The interaction effect of pruning intensity and pruning time (P × T) on fruit volume was found non- significant.

The increase in fruit volume with pruning intensity was also reported by Shinde *et al.* (2020) in guava cv. Sardar. He further stated that this might be attributed to the fact that pruning may increases the absorption of water and other nutrients, mobilization of minerals and encourages the growth of the developing fruits. Moreover, pruning enhances physiology of leaves, thereby causing better translocation of nutrients and vital components in the developing fruits.

4.3.1.3 Fruit length

The data enumerated in Table 4.9 showed a significant effect of pruning intensity and pruning time on fruit length. Among different pruning intensities, 20 cm shoot pruning from the terminal portion (P₃) produced fruits with maximum length (6.30 cm) which was found statistically similar with treatment P₂ (6.27 cm) whereas, minimum fruit length (6.21 cm) was recorded in fruits obtained from plants subjected to 10 cm shoot pruning from the tip.

Among the different pruning times plants which were pruned during 1st week of May resulted in fruits with highest fruit length (6.43 cm) which was statistically at par with treatment T₂ (6.37 cm). However, lowest fruit length (5.99 cm) was found in fruits picked plants pruned during 3rd week of July (T₆).

The interaction between pruning intensity and time of pruning ($P \times T$) was found significant. Maximum fruit length (6.51 cm) was recorded in the fruits picked from plants shoot pruned to 20 cm shoot pruning from apex during 1st week of May followed by treatment P_3T_2 (6.42 cm) while, minimum fruit length (5.86 cm) was recorded in fruits obtained from lightly pruned plants during 3rd week of July.

The study revealed that early and severe pruning produced fruits with maximum fruit length. The results of the present study corroborate with the findings of Adhikari and Kandel (2015) and Singh *et al.* (2001). Similarly, Pandey *et al.* (2020) reported that 50 per cent shoot pruning performed during mid- May resulted in maximum fruit length. Kumar and Rattanpal (2010) stated that the increase in fruit length is probably due to more availability of metabolites and water to relatively fewer fruits. Prakash *et al.* (2012) opined that guava fruit size has inverse correlation with number of fruits borne on the trees. The highest fruit length is probably due to the high leaf to fruit ratio and availability of more photosynthates due to lesser number of fruits.

Table 4.9 Effect of pruning intensity and time of pruning on fruit length and fruit width in guava.

Pruning treatments	Fruit length (cm)				Fruit breadth (cm)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	6.36	6.41	6.51	6.43	6.34	6.37	6.44	6.38
T ₂ : 3 rd week of May	6.34	6.36	6.42	6.37	6.32	6.36	6.39	6.36
T ₃ : 1 st week of June	6.29	6.32	6.33	6.31	6.25	6.29	6.29	6.27
T ₄ : 3 rd week of June	6.22	6.25	6.27	6.25	6.20	6.24	6.25	6.23
T ₅ : 1 st week of July	6.19	6.22	6.22	6.21	6.17	6.21	6.20	6.19
T ₆ : 3 rd week of July	5.86	6.06	6.05	5.99	6.04	6.12	6.17	6.11
Mean	6.21	6.27	6.30		6.22	6.26	6.29	
CD _{0.05}	P: 0.03 T: 0.04 P X T: 0.07				P: 0.02 T: 0.03 P X T: NS			

4.3.1.4 Fruit breadth

A cursory view of data presented in Table 4.9 depicted a significant effect of pruning intensity on fruit width. Among different pruning intensities, maximum fruit



Fruits obtained from 20 cm
shoot pruned plants during
1st week of May

Fruits obtained from 20 cm
shoot pruned plants during 3rd
week of May

Fruits obtained from 15 cm
shoot pruned plants during
1st week of May

PLATE 5. FRUITS QUALITY UNDER DIFFERENT TREATMENTS

breadth (6.29 cm) was found in fruits obtained from severely pruned plants (P₃) which was found at par with treatment P₂ (6.26 cm) while, minimum fruit breadth (6.22 cm) was observed in fruits obtained from lightly pruned plants (P₁).

Among different pruning times maximum fruit breadth (6.38 cm) was found in fruits harvested plants pruned during 1st week of May (T₁) which was found significantly at par with treatment T₂ (6.36 cm). Minimum fruit breadth (6.11 cm) was recorded in fruits obtained from plants pruned during 3rd week of July (T₆).

However, the interaction between pruning intensity and time of pruning was found non- significant.

The results obtained are in conformity with the findings of Sah *et al.* (2017), Brar *et al.* (2007). The increase in the fruit size may be due to less number of fruits resulting in accumulation and utilization of more metabolites and nutrients by the developing fruits. Patel *et al.* (2014) stated that the increase in fruit size with severe pruning intensity might be due to more nutrient supply to comparatively lesser number of fruits in case of severe pruning. Lesser number of fruits minimizes the competition for nutrients between the developing fruit allowing individual fruit to has more share of resources which allows the cell elongation, resulting in greater accumulation of the food materials in the developing fruits. The pronounced effect of early pruning on fruit size might be due to the prevalence of optimum temperature which enhances the metabolic and physiological processes of plants resulting in maximum size of the fruits (Singh *et al.*, 2001). The maximum fruit size, weight and fruit volume in fruits obtained from early pruned plants might be ascribed to the fact that this time is better for pruning which increases metabolic and physiological processes of plant resulting in maximum fruit weight, fruit size and fruit volume Singh *et al.* (1996).

4.3.2 Biochemical attributes

4.3.2.1 Total Soluble Solids (TSS)

The data enumerated in Table 4.10 indicates the effect of pruning intensity and pruning time on fruit TSS. It is evident from the data that irrespective of the time of

pruning, pruning intensity exhibited a significant influence on fruit TSS. Maximum fruit TSS (9.48 °B) was recorded in fruits obtained from plants pruned to 20 cm from the shoot tip which was found statistically at par with treatment P₂ (9.45 °B). However, minimum TSS (9.38 °B) was recorded in fruits harvested from lightly pruned plants.

Pruning time also exhibited a significant influence on fruit TSS. Among different pruning times, plants pruned during 1st week of May (T₁) resulted in maximum fruit TSS (9.60 °B) which was statistically at par with treatment T₂ (9.56 °B) while, minimum fruit TSS (9.20 °B) was observed in fruits obtained from plants pruned during 3rd week of July (T₆).

The interaction between pruning intensity and pruning time (P × T) was also found to be significant with respect to fruit TSS. Plants subjected to severe pruning during 1st week of May produced fruits with maximum fruit TSS (9.63 °B) which was found to be statistically at par with treatment combination P₂T₁ (9.62 °B) and P₃T₂ (9.61 °B).

Samant and Kishore (2019) reported highest fruit TSS in the fruits picked from severely pruned trees during May. The increase in the TSS may be due to the better light penetration within the tree canopy which resulted in increased rate of photosynthesis and more accumulation of carbohydrates. The results of the present study corroborate with the findings of Bhagwati *et al.* (2015), Dhaliwal and Singh (2004), Brar *et al.* (2007) and Prakash *et al.* (2012) who reported maximum TSS in severely pruned plants. Similarly, Pandey *et al.* (2020) observed maximum TSS in fruits obtained from severely pruned plants during May. They further opined that this increase may be due to more leaf to fruit ratio which probably has resulted in more metabolites synthesis and ultimately higher fruit TSS. The maximum TSS in early pruned plants is probably associated with the optimum temperature prevailed during the fruit development period which promotes the rate of photosynthesis and results in more fruit TSS.

4.3.2.2 Titratable acidity

The perusal of data presented in Table 4.10 showed that acidity followed a decreased trend with the increase in pruning intensity. Maximum acidity (0.53 %) was found in fruits obtained from plants subjected to 10 cm shoot pruning followed by 15 cm shoot pruning (0.51 %) while, minimum acidity (0.50 %) was observed in fruits obtained from plants subjected to 20 cm shoot pruning from tip.

Table 4.10 Effect of pruning intensity and time of pruning on TSS and acidity in guava.

Pruning treatments	TSS (^o B)				Acidity (%)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	9.54	9.62	9.63	9.60	0.47	0.45	0.40	0.44
T ₂ : 3 rd week of May	9.51	9.57	9.61	9.56	0.51	0.49	0.47	0.49
T ₃ : 1 st week of June	9.46	9.48	9.52	9.49	0.53	0.49	0.49	0.51
T ₄ : 3 rd week of June	9.42	9.50	9.49	9.47	0.54	0.53	0.53	0.53
T ₅ : 1 st week of July	9.16	9.34	9.38	9.29	0.55	0.56	0.55	0.55
T ₆ : 3 rd week of July	9.16	9.21	9.22	9.20	0.57	0.57	0.55	0.56
Mean	9.38	9.45	9.48		0.53	0.51	0.50	
CD_{0.05}	P:	0.02			P:	0.01		
	T:	0.03			T:	0.01		
	P X T:	0.06			P X T:	0.02		

A significant increase in fruit acidity was also observed with delayed pruning. Highest acidity (0.56 %) was found in fruits obtained from plants pruned during 3rd week of July which was found statistically at par with T₅ (0.55 %) while, lowest acidity (0.44 %) was observed in fruits picked from plants pruned during 1st week of May (T₁).

The interaction between pruning intensity and pruning time (P X T) on acidity was also found significant. Maximum fruit acidity (0.57 %) was observed in fruits harvested from lightly pruned plants during 3rd week of July (T₆) while, minimum acidity (0.40 %) was found in fruits produced from plants pruned to 20 cm from the shoot tip during the 1st week of May.

It is evident from the data furnished in Table 4.10 that with the decrease in pruning severity and delayed pruning fruit acidity increased. The results of the present study are in consonance with those of Samant *et al.* (2016), Brar *et al.* (2007) and Sharma *et al.* (2013) in guava. The decrease in acidity might be due to lower rate of reduction of starch to sugars (Parmar *et al.* 2019). Increase in pruning severity induces reduction in shading, which increases the light penetration into the interior parts of plant canopy. More light interception enhances the synthesis of carbohydrates and their translocation to the production sites which helps improving the fruit quality (Mohamed *et al.*, 2014).

4.3.2.3 Ascorbic acid content

The data regarding the influence of pruning intensity and time of pruning on ascorbic acid content is furnished in Table 4.11. It is clear from the data presented that different levels of pruning intensities exhibited a significant influence on ascorbic acid content. Maximum ascorbic acid content (173.06 mg/ 100 g) was found in plants subjected to 20 cm shoot pruning from the apex which was found statistically at par with treatment P₂ (171.07 mg/ 100 g) whereas, minimum ascorbic acid content (169.34 mg/ 100 g) was found in fruits obtained from lightly pruned plants (P₁).

The time of pruning time also exhibited a significant effect on ascorbic acid content. Maximum ascorbic acid (180.11 mg/ 100 g) was found in fruits harvested from plants pruned during 1st week of May (T₁) while, minimum ascorbic acid (162.28 mg/ 100 g) was recorded in fruits produced from plants pruned during 3rd week of July (T₆). However, the interaction between pruning intensity and pruning time on ascorbic acid content was found non- significant.

In accordance to the findings of the current study Choudhary *et al.* (2020) opined that this might be due to the abundant availability of photosynthates for limited number of fruits leading to increase in ascorbic acid. As well as prevalence of low temperature during fruit development increases the ascorbic acid content in the fruits. The results are similar to the findings of Dubey *et al.* (2002), Prakash *et al.* (2012) and Mali *et al.* (2016) who registered the highest ascorbic acid content in fruits produced by trees subjected to severe pruning. Lal *et al.* (2007) stated that higher ascorbic acid may be due to the prevalence of low temperature received at the time of

fruit ripening, which not only retarded the excessive loss of exspiratory substances but also increased the translocation of photosynthates from leaves to the developing fruits.

4.3.2.4 TSS/ acid ratio

The data pertaining to the influence of pruning intensity and pruning time on TSS/ acid ratio of fruit is furnished in the Table 4.11. The data revealed that among the different pruning intensities severely pruned plants (P₃) produced fruits with maximum TSS/ acid ratio (18.87) while, minimum TSS/ acid ratio (17.57) was observed in fruits obtained from lightly pruned plants (P₁).

Among different pruning time, plants pruned on 3rd week of May (T₁) produced fruits with highest TSS/ acid ratio (21.75) followed by T₂ (19.47) while, minimum TSS/ acid ratio (15.72) was found in fruits obtained from plants pruned on 3rd week of July (T₆).

Table 4.11 Effect of pruning intensity and time of pruning on TSS/ acidity and ascorbic acid in guava.

Pruning treatments	TSS / Acidity				Ascorbic acid (mg/ 100 g)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	20.21	21.34	23.71	21.75	176.95	180.83	182.55	180.11
T ₂ : 3 rd week of May	18.66	19.49	20.26	19.47	174.77	175.58	178.92	176.42
T ₃ : 1 st week of June	17.67	19.05	19.04	18.58	170.78	173.23	174.20	172.74
T ₄ : 3 rd week of June	17.36	17.66	17.88	17.63	169.08	169.85	171.04	169.99
T ₅ : 1 st week of July	15.72	16.73	16.83	16.43	163.50	164.95	168.54	165.67
T ₆ : 3 rd week of July	15.76	15.86	15.54	15.72	160.94	161.96	163.96	162.28
Mean	17.57	18.35	18.87		169.34	171.07	173.20	
CD_{0.05}	P:	0.39			P:	1.61		
	T:	0.56			T:	2.28		
	P X T:	0.97			P X T:	NS		

The interaction between pruning intensity and pruning time on TSS/ acid ratio was found significant. Highest TSS/ acid ratio (23.71) was found in fruits harvested from plants which were pruned to 20 cm from the shoot tip during 1st week of May followed by treatment combination P₂T₁ (21.34). However, minimum TSS/ acid ratio was found in fruits obtained from lightly pruned plants during 3rd week of July which

was statistically at par with treatment combination P₂T₆ (15.86), P₁T₆ (15.76), P₁T₅ (15.72).

The results of the present study are in line with the findings of Samant *et al.* (2016). This might be due to healthy shoot canopy, better light distribution in within the canopy, proper utilization of sun light and higher photosynthetic rate in severely pruned plants (Choudhary *et al.* 2020). The increase and decrease in the ratio is primarily due to the variation in this response to pruning. Kumar *et al.* (2010) stated that increased leaf size improved photosynthetic rates resulting in the enhancement of plant food material amounts for the nourishment of developing fruits.

4.3.2.6 Reducing sugars

A cursory view of data presented in Table 4.12 depicted an increasing trend of reducing sugars with increasing pruning intensity. Highest reducing sugar (4.28 %) was obtained in fruits harvested from trees subjected to 15 cm pruning from the shoot tip (P₂) which was found statistically at par with treatment P₃ (4.27 %).

Among different pruning times, plants pruned during 1st week of May produced fruits with maximum reducing sugars (4.45 %). However, minimum reducing sugar (4.08 %) was observed in fruits obtained from plants pruned during 3rd week of July (T₆).

The interaction between pruning intensity and time of pruning exhibited a significant effect of reducing sugar. Maximum reducing sugar (4.51 %) was found in fruits produced were pruned to 15 cm from the shoot tip during 1st week of May followed by treatment combination P₁T₁ (4.44 %) whereas, minimum reducing sugar (3.98 %) was found in fruits obtained from lightly pruned plants during 3rd week of July (P₁T₆).

The data obtained here revealed that early pruning resulted in fruits with highest sugars. The probable reason for this increase might be due to the more synthesis of carbohydrates, increased photosynthates translocation, nutrient uptake and deposition to fruit tissues that improves the qualitative characteristics of fruits (Singh *et al.*, 2012).

4.3.2.5 Total sugars

The critical examination of data presented in Table 4.12 showed a significant effect of pruning intensities on total sugars. The above data revealed that total sugars showed an increasing trend with the increase in pruning severity. Highest total sugars (5.91 %) were observed in fruits obtained from plants pruned to 20 cm from the shoot tip followed by treatment P₂ (5.85 %).

It is evident from the data presented that delayed pruning time decreased the total sugar content of the fruits. Among different pruning times, plants pruned during 1st week of May produced fruits with maximum total sugars (6.24 %) which was found statistically at par with treatment T₂ (6.20 %) while, minimum total sugars (5.30 %) was observed in fruits obtained from plants pruned during 3rd week of July.

Table 4.12 Effect of pruning intensity and time of pruning on reducing sugar and total sugar in guava.

Pruning treatments	Reducing sugar (%)				Total sugar (%)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	4.44	4.51	4.41	4.45	6.21	6.24	6.26	6.24
T ₂ : 3 rd week of May	4.35	4.39	4.41	4.38	6.17	6.21	6.23	6.20
T ₃ : 1 st week of June	4.25	4.24	4.25	4.25	5.86	6.00	5.98	5.95
T ₄ : 3 rd week of June	4.11	4.20	4.27	4.19	5.75	5.81	5.90	5.82
T ₅ : 1 st week of July	4.13	4.19	4.17	4.17	5.54	5.58	5.69	5.61
T ₆ : 3 rd week of July	3.98	4.13	4.13	4.08	5.23	5.27	5.39	5.30
Mean	4.21	4.28	4.27		5.80	5.85	5.91	
CD_{0.05}	P: 0.39				P: 1.61			
	T: 0.56				T: 2.28			
	P X T: 0.97				P X T: NS			

The interaction between pruning intensity and pruning time (P × T) on total sugars was found non-significant. Highest total sugar (6.26 %) was found in fruits obtained from plants which were pruned to 20 cm from the shoot tip during 1st week of May (P₃T₁) whereas, minimum total sugars (5.23 %) was observed in treatment combination fruits harvested from lightly pruned plants during 3rd week of July (T₆).

The results of the present study are in conformity with the findings of Basu *et al.* (2007) and Kumar and Rattanpal (2010). This might be due to increase in nutrient uptake by the trees and consequently more synthesis of carbohydrates and other metabolites and their translocation to the fruits. These results are conformity with the findings of Sawant *et al.* (2018). Pruning increases the activity of enzymes such as amylose which hydrolyze complex polysaccharides into simple sugars which further accelerates the translocation of metabolites towards developing fruits (Shinde *et al.* 2020).

4.3.2.7 Non- reducing sugars

The data pertaining to the effect of pruning intensity and pruning time is presented in Table 4.13. The data revealed that the pruning intensity had a significant effect on non- reducing sugar. Maximum non- reducing sugar (1.55 %) was found in fruits harvested from severely pruned plants (P₃) which was found statistically similar with treatment P₁ (1.51 %).

Table 4.13 Effect of pruning intensity and time of pruning on non- reducing sugars in guava.

Pruning treatments	Non- reducing sugar (%)			
	P ₁ 10 cm	P ₂ 15 cm	P ₃ 20 cm	Mean
T ₁ : 1 st week of May	1.68	1.64	1.76	1.70
T ₂ : 3 rd week of May	1.72	1.70	1.73	1.73
T ₃ : 1 st week of June	1.54	1.67	1.65	1.62
T ₄ : 3 rd week of June	1.56	1.54	1.56	1.55
T ₅ : 1 st week of July	1.34	1.32	1.44	1.37
T ₆ : 3 rd week of July	1.20	1.08	1.19	1.15
Mean	1.51	1.49	1.55	
CD_{0.05}	P:	0.04		
	T:	0.06		
	P X T:	NS		

Among different pruning times, plants pruned during 3rd week of May resulted in maximum non- reducing sugar (1.73 %) which was statistically at par with

treatment T₁ (1.70 %). However, pruning done during 3rd week of July produced fruits with minimum non- reducing sugar (1.15 %).

The interaction effect of pruning intensity and pruning time on non- reducing sugar was found non- significant. However, maximum non- reducing sugar (1.76 %) was observed in fruits obtained from 20 cm shoot pruning during 1st week of May (P₁ T₁) while, minimum non- reducing sugar (1.08 %) was found in fruits harvested from treatment combination 15 cm shoot pruning during 3rd week of July (P₂T₆).

Chapter-5

SUMMARY AND CONCLUSION

The present investigation entitled “**Studies on the effect of pruning intensities and time on winter guava production in cv. Allahabad Safeda under high density planting**” was carried out during the year 2020 and 2021 at the experimental guava farm of Department of Fruit Science, College of Horticulture and Forestry, Neri, Hamirpur. The salient achievements of the present studies are summarized hereunder:

- Among different pruning intensities, guava plants pruned to 10 cm from the shoot tip (P_1) produced maximum increase in plant height (53.55 cm), trunk girth (2.37 cm), shoot diameter (0.78 cm), canopy volume (2.40 m^3), trunk cross-sectional area (27.04 cm^2) and canopy spread in East- West (0.51 m) and North -South (0.49 m) direction while, severely pruned plants (20 cm from the shoot tip) induced maximum shoot length (34.27 cm) and leaf area (59.19 cm^2).
- For reproductive attributes, plants pruned to 10 cm from the shoot tip (P_1) induced earliest flower emergence (43.22 days), maximum number of flowers per shoot (5.38), fruit set (32.24 %) and maximum fruit yield (7.29 kg/tree).
- The severest pruning intensity (20 cm from the shoot tip) produced fruits with highest fruit weight (145.49 g), fruit volume (151.91 cm^3), fruit length (6.30 cm), fruit width (6.29 cm), TSS (9.48 °B), ascorbic acid content, TSS/acid ratio (18.87), total sugars (5.91 %), non- reducing sugars (1.55 %) and minimum titratable acidity (0.50 %) while, maximum reducing sugar (4.28 %) was found in fruits obtained from 15 cm pruned plants.
- Among different pruning times, plants pruned during 1st week of May resulted in maximum increase in plant height (56.00 cm), trunk girth (2.47 cm), shoot diameter (0.99 cm), leaf area (64.57 cm^2), trunk cross sectional area (29.20 cm^2), canopy volume (2.95 cm^3), shoot length (42.62 cm) and plant canopy spread in East- West (0.54 m) and North- South direction (0.52 m).
- A significant variation on plant reproductive characteristics with different pruning times was observed. Guava plants pruned during 1st week of May took minimum

time for flower emergence (39.38 days), produced maximum number of flowers per shoot (7.04), maximum fruit set (40.95 %) and fruit yield (8.26 kg/plant).

- The plants pruned during 1st week of May (T₁) produced fruits with maximum fruit weight (150.60 g), fruit volume (158.76 cm³), fruit length (6.43 cm), width (6.38 cm). With respect to biochemical parameters earliest pruned plants (T₁) resulted in fruits with maximum fruit TSS (9.60 °B), ascorbic acid content (180.11 mg/ 100 g), TSS/ acid ratio (21.75), total sugars (6.24 %), reducing sugars (4.45 %) and minimum acidity (0.44 %) while, maximum non- reducing sugar (1.73 %) was observed in fruits harvested from 3rd week of May.
- Interaction between pruning time and pruning intensity showed a significant influence on vegetative growth characteristics. Maximum increase in plant height (61.16 cm), trunk girth (2.55 cm), shoot diameter (1.07 cm), canopy volume (3.40 m³), plant canopy spread in East-West (0.56 m) and North- South direction (0.56 m) was recorded in plants pruned to 10 cm during 1st week of May (P₁T₁) while, maximum shoot length (47.11 cm), leaf area (68.58 cm²) and trunk cross sectional area (29.97 cm²) was found in plants pruned to 20 cm during 1st week of May (P₃T₁).
- Lightly pruned plants during 1st week of May resulted in earliest flower emergence (38.16 days), maximum number of flowers per shoot (7.42), fruit set (43.73 %) and fruit yield (8.80 kg/ plant).
- The severest pruning intensity performed during 1st week of May (P₃T₁) produced fruits with maximum fruit weight (156.12 g), fruit volume (162.01 cm³), fruit length (6.51 cm) and fruit width (6.44 cm). Biochemical parameters also showed a significant variation with different pruning times. Maximum TSS (9.63 °B), ascorbic acid (182.55 mg/ 100 g), TSS/ acid ratio (23.71), total sugars (6.26 %), reducing sugars (4.48 %), and minimum acidity (0.40 %) while, maximum non-reducing sugar (1.76 %) was found in fruits harvested from lightly pruned plants during 1st week of May (P₁T₁).

CONCLUSION

From the present study, it can be concluded that pruning intensities and time of pruning significantly influenced vegetative, reproductive and qualitative attributes of the plant. Among different pruning intensities, light pruning performed best in terms

of vegetative and reproductive growth of the plant. Light pruning intensity was found beneficial for improving yield of guava plants while, severest pruning was found effective in enhancing physico- chemical attributes of guava fruits. Among different pruning times, earliest shoot pruning (1st week of May) was found superior in terms of vegetative, reproductive and quality attributes of guava. The study clearly revealed that among the different treatment combinations plants pruned to 20 cm during 1st week of May produced good quality fruits while, light pruning conducted during 1st week of May resulted in higher fruit yield.

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APPENDIX- 1

ANALYSIS OF VARIENCE

Experiment: Studies on the effect of pruning intensities and time on winter guava production in cv. Allahabad Safeda under high density planting.

ANOVA for the effect of pruning intensity and time of pruning on plant height in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	54.185		
Time (T)	5	1,743.296	348.659	35.080
Intensity (P)	2	610.685	305.343	30.722
Interaction T X P	10	200.315	20.031	2.015
Error	85	844.815	9.939	
Total	107	3,453.296		

*Significant at 5 % level of significance

ANOVA for the Effect of pruning intensity and time of pruning on leaf area in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	11.562		
Time (T)	5	2,629.222	525.844	63.725
Intensity (P)	2	383.575	191.788	23.242
Interaction T X P	10	89.885	8.989	1.089
Error	85	701.399	8.252	
Total	107	3,815.643		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on canopy spread in East- West direction guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.002		
Time (T)	5	0.237	0.047	51.415
Intensity (P)	2	0.036	0.018	19.268
Interaction T X P	10	0.006	0.001	0.671
Error	85	0.079	0.001	
Total	107	0.360		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on canopy spread in North- South direction in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.002		
Time (T)	5	0.143	0.029	16.226
Intensity (P)	2	0.022	0.011	6.193
Interaction T X P	10	0.003	0.000	0.192
Error	85	0.149	0.002	
Total	107	0.319		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on Trunk girth in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.006		
Time (T)	5	1.202	0.240	141.050
Intensity (P)	2	0.078	0.039	22.811
Interaction T X P	10	0.039	0.004	2.269
Error	85	0.145	0.002	
Total	107	1.470		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on shoot length in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	37.257		
Time (T)	5	3,464.306	692.861	108.518
Intensity (P)	2	151.215	75.607	11.842
Interaction T X P	10	164.695	16.470	2.580
Error	85	542.705	6.385	
Total	107	4,360.177		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on shoot diameter in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.008		
Time (T)	5	2.412	0.482	119.828
Intensity (P)	2	0.037	0.019	4.613
Interaction T X P	10	0.070	0.007	1.730
Error	85	0.342	0.004	
Total	107	2.868		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on canopy volume in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	4.782		
Time (T)	5	20.711	4.142	8.304
Intensity (P)	2	0.128	0.064	0.129
Interaction T X P	10	4.999	0.500	1.002
Error	85	42.400	0.499	
Total	107	73.020		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on trunk cross-sectional area in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	53.360		
Time (T)	5	312.026	62.405	6.424
Intensity (P)	2	3.488	1.744	0.180
Interaction T X P	10	63.786	6.379	0.657
Error	85	825.753	9.715	
Total	107	1,258.413		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on days for first flower emergence in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	6.407		
Time (T)	5	843.963	168.793	205.180
Intensity (P)	2	45.241	22.620	27.497
Interaction T X P	10	16.315	1.631	1.983
Error	85	69.926	0.823	
Total	107	981.852		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on number of flowers per shoot in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.899		
Time (T)	5	152.031	30.406	105.818
Intensity (P)	2	6.032	3.016	10.497
Interaction T X P	10	0.676	0.068	0.235
Error	85	24.424	0.287	
Total	107	184.062		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on fruit set in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	7.374		
Time (T)	5	1,727.376	345.475	257.658
Intensity (P)	2	82.998	41.499	30.950
Interaction T X P	10	35.347	3.535	2.636
Error	85	113.970	1.341	
Total	107	1,967.065		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on fruit yield in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.596		
Time (T)	5	42.497	8.499	106.087
Intensity (P)	2	1.790	0.895	11.172
Interaction T X P	10	1.638	0.164	2.044
Error	85	6.810	0.080	
Total	107	53.331		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on fruit weight in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	92.818		
Time (T)	5	6,837.389	1,367.478	57.487
Intensity (P)	2	964.301	482.150	20.269
Interaction T X P	10	677.456	67.746	2.848
Error	85	2,021.940	23.788	
Total	107	10,593.904		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on fruit volume in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	214.419		
Time (T)	5	5,597.039	1,119.408	68.919
Intensity (P)	2	214.087	107.044	6.590
Interaction T X P	10	43.438	4.344	0.267
Error	85	1,380.595	16.242	
Total	107	7,449.577		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on fruit length in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.019		
Time (T)	5	2.190	0.438	85.927
Intensity (P)	2	0.168	0.084	16.501
Interaction T X P	10	0.122	0.012	2.387
Error	85	0.433	0.005	
Total	107	2.932		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on fruit width in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.031		
Time (T)	5	0.966	0.193	81.277
Intensity (P)	2	0.089	0.044	18.610
Interaction T X P	10	0.024	0.002	1.001
Error	85	0.202	0.002	
Total	107	1.312		

*Significant at 5 % level of significance

ANOVA for the Effect of pruning intensity and time of pruning on TSS in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.007		
Time (T)	5	2.217	0.443	152.589
Intensity (P)	2	0.194	0.097	33.401
Interaction T X P	10	0.068	0.007	2.354
Error	85	0.247	0.003	
Total	107	2.734		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on titratable acidity in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.006		
Time (T)	5	0.192	0.038	68.319
Intensity (P)	2	0.015	0.007	13.108
Interaction T X P	10	0.012	0.001	2.053
Error	85	0.048	0.001	
Total	107	0.272		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on TSS/acidity in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	6.628		
Time (T)	5	431.861	86.372	120.301
Intensity (P)	2	31.240	15.620	21.756
Interaction T X P	10	27.846	2.785	3.878
Error	85	61.027	0.718	
Total	107	558.601		

*Significant at 5 % level of significance

ANOVA for the Effect of pruning intensity and time of pruning on ascorbic acid in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	62.106		
Time (T)	5	3,970.234	794.047	68.554
Intensity (P)	2	269.202	134.601	11.621
Interaction T X P	10	45.786	4.579	0.395
Error	85	984.533	11.583	
Total	107	5,331.861		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on total sugars in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.059		
Time (T)	5	11.760	2.352	441.768
Intensity (P)	2	0.237	0.119	22.262
Interaction T X P	10	0.066	0.007	1.241
Error	85	0.453	0.005	
Total	107	12.575		

Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on reducing sugars in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.033		
Time (T)	5	1.760	0.352	62.010
Intensity (P)	2	0.103	0.051	9.057
Interaction T X P	10	0.116	0.012	2.037
Error	85	0.482	0.006	
Total	107	2.493		

*Significant at 5 % level of significance

ANOVA for the effect of pruning intensity and time of pruning on non- reducing sugars in guava

Source of Variation	DF	Sum of Squares	Mean Squares	F-Calculated
Replication	5	0.126		
Time (T)	5	4.378	0.876	82.721
Intensity (P)	2	0.070	0.035	3.328
Interaction T X P	10	0.134	0.013	1.266
Error	85	0.900	0.011	
Total	107	5.608		


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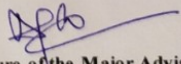
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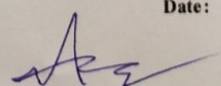
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ABSTARCT

The present investigations "Studies on the effect of pruning intensities and time on winter guava production in cv. Allahabad Safeda under high density planting" were carried out at the experimental farm of Department of Fruit Science, College of Horticulture and Forestry Neri, Hamirpur (H.P.), during the year 2020-2021. The research trial was conducted on four years old guava plants, planted at 2 x 2 m spacing. The plants were subjected to three pruning intensities viz., 10, 15 and 20 cm shoot pruning from the terminal portion at different times i.e., 1st and 3rd week of May, June and July. Among the different pruning times, severely pruned plants (20 cm pruning from the shoot tip) produced best results with respect to shoot length (34.27 cm) and leaf area (59.19 cm²). Shoot pruning done at 10 cm from the terminal portion was found better for improving reproductive characteristics of guava plants i.e., minimum time taken for flower emergence (43.22), fruit set (32.24 %) and fruit yield (7.29 kg). Severe pruning (20 cm from the shoot tip) produced comparatively superior quality fruits. Among different pruning times, plant pruned during 1st week of May effectively improved vegetative, reproductive and qualitative characteristics of the guava fruits. The study clearly revealed that light pruning intensity (10 cm shoot pruning from the terminal portion) performed during 1st week of May was found effective in improving fruit set (43.73%) and fruit yield (8.80 kg/plant) whereas, 20 cm shoot pruning performed during 1st week of May was found effective in improving physical and qualitative attributes of fruits i.e., fruit weight (156.12 g), fruit volume (162.01 cm³), fruit length (6.51 cm), TSS (9.63 °B), ascorbic acid (182.55 mg/100g).


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