STUDIES ON THE EFFECT OF TIME OF PRUNING ON BER (*Zizyphus mauritiana* Lamk) UNDER TIRUPATI (ANDHRA PRADESH) CONDITIONS

By

K. VIJAY KUMAR, B.Sc., (Ag.)

THESIS SUBMITTED TO THE
ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
IN PARTIAL FULFILMENT OF THE REQUIREMENTS
FOR THE AWARD OF THE DEGREE OF

MASTER OF SCIENCE IN AGRICULTURE

(HORTICULTURE)

DEPARTMENT OF HORTICULTURE
SRI VENKATESWARA AGRICULTURAL COLLEGE
ACHARYA N.G. RANGA AGRICULTURAL UNIVERSITY
TIRUPATI - 517 502 (A.P.)

FEBRUARY, 1999

CERTIFICATE

Mr.K.VIJAY KUMAR has satisfactorily prosecuted the course of research and that the thesis entitled **"STUDIES ON THE EFFECT OF TIME OF PRUNING ON BER (*Zizyphus mauritiana* Lamk) UNDER TIRUPATI (ANDHRA PRADESH) CONDITIONS"** submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitted by him for a degree of any university.

Date : 12.8.99.

(Dr. R.SRIHARI BABU)
Major Advisor
Professor and Head
Dept. of Horticulture
S.V.Agril.College,
Tirupati

CERTIFICATE

This is to certify that the thesis entitled **"STUDIES ON THE EFFECT OF TIME OF PRUNING ON BER (*Zizyphus mauritiana* Lamk) UNDER TIRUPATI (ANDHRA PRADESH) CONDITIONS"** submitted in partial fulfilment of the requirements for the degree of **Master of Science in Agriculture** of the **Acharya N.G.Ranga Agricultural University**, Hyderabad, is a record of the bonafide research work carried out by **Mr. K.VIJAYKUMAR** under my guidance and supervision. The subject of the thesis has been approved by the **Student's Advisory Committee.**

No part of the thesis has been submitted for any other degree or diploma or has been published. The published part has been fully acknowledged. All assistance and help received during the course of the investigations have been duly acknowledged by him.

R. Srihari Babu 12/2/99

(Dr.R. SRIHARI BABU)
Chairman of the Advisory Committee

The thesis is approved by the Student Advisory Committee :

Chairman : **(Dr. R.SRIHARI BABU)** R. Srihari Babu 12/2/99
Professor and Head
Department of Horticulture
S.V.Agricultural College
Tirupati.

Member : **(Dr.K.HARI BABU)** 3/2/99
Associate Professor
Department of Horticulture
S.V.Agricultural College
Tirupati.

Member : **(Dr.J. SURYA PRAKASA RAO)**
Assoc. Professor and Head
Dept. of Plant Physiology
S.V.Agril College,
Tirupati.

Associate Professor & Head
Dept. of Plant Physiology
S. V. Agricultural College
TIRUPATI - 517 502 (A.P.)

CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

LIST OF PLATES

LIST OF ABBREVIATIONS

cc	-	cubic centimeters
cm	-	centimeters
DAF	-	Days after flowering
DAS	-	Days after sprouting
g	-	grams
kg	-	kilograms
mt	-	meters
No.	-	Number
@	-	At the rate of

ACKNOWLEDGEMENT

It gives me immense pleasure to express my deep sense of gratitude and sincere thanks to ***Dr. R.Sri Hari Babu,*** *Professor and Head of the Department of Horticulture and Chairman of the Advisory Committee, for suggesting the research problem and for his valuable guidance, constructive criticism and help during the progress of research work and in preparation of the thesis.*

I am extremely thankful to my Advisory Committee ***Dr. K. Hari Babu,*** *Associate Professor, Department of Horticulture and* ***Dr. J.Surya Prakasa Rao,*** *Associate Professor and Head, Department of plant physiology for their constant advice during the period of study and finalisation of the thesis.*

I wish to express my sincere thanks to ***Dr. N. Venugopal Rao,*** *Professor and Head of the Department (Entomology), and* ***Sri P. Rajendra Prasad,*** *Assistent Professor, Department of Entomology for their valuable help in carryingout research work.*

I express my heartful thanks to my colleagues ***Ramakrishna, Ravichandrudu, Hari Babu, Mohan, Kalaisekar, Syam, Soban, Tirumal, Sridhar, Upendra, Jaffar, Khayum*** *and junior friends* ***Humayun, Prakash, Gopi, Chitti Babu, Sadarunnisa, Shree Prakash, Kaladhar, Devendar, Vijaya Bhaskar, Bharat Babu, Gurunath*** *and my senior friends* ***Khadri, Lakshmi, Srinivas*** *and other post graduate friends for their co-operation and constant encouragement.*

I owe gratitude to my reverened parents ***Sri K. Sree Ramulu*** *and* ***Smt.K.Narayanamma,*** *Brother* ***Ravi Kumar,*** *Sister* ***Jhansi*** *and Brother-in-law* ***M. Narasimha,*** *Uncle* ***M.Chandraiah*** *and other family members for their inspiring encouragement during my studies.*

The financial help given by the Government of A.P. in the form of stipend is gratefully acknowledged.

(K.VIJAY KUMAR)

DECLARATION

I, **K. VIJAY KUMAR**, hereby declare that the thesis entitled **"STUDIES ON THE EFFECT OF TIME OF PRUNING ON BER (*Zizyphus mauritiana* Lamk) UNDER TIRUPATI (ANDHRA PRADESH) CONDITIONS"** is a result of the original research work done by me. It is further declared that the thesis or any part there of has not been published earlier in any manner.

(K. VIJAY KUMAR)

ABSTRACT

Name of the Author	:	**K. Vijay Kumar**
Title of the Thesis	:	Studies on the effect of time of pruning on ber (*Zizyphus mauritiana* Lamk) under Tirupati (Andhra Pradesh) conditions.
Submitted for the Award of the Degree	:	Master of Science in Agriculture
Faculty	:	Agriculture
Department	:	Horticulture
Major Advisor	:	Dr.R. SriHari Babu
University	:	Acharya N.G.Ranga Agricultural University
Year of Submission	:	February, 1999

An experiment entitled "Studies on the effect of time of pruning on Ber (*zizyphus mauritiana Lamk*) under Tirupati (Andhra Pradesh) conditions" was carriedout at the S.V.Agricultural College, Tirupati during March 1998 to December 1998. The trees were pruned on five different dates at fortnightly intervals from 1st March to 30th April. The experiment was laid out in RBD and the treatments were replicated four times.

Different dates of pruning had significantly influenced the vegetative growth, flowering, yield and fruit quality of ber. However, in respect of tree characters, the dates of pruning failed to show significant difference among themselves. Early pruning resulted in early sprouting of vegetative buds and early flowering which resulted in early harvesting. The production of new shoots was greater and production of laterals was lower as the pruning was delayed.

Highest yields were obtained from trees pruned on 31st March and least from those pruned on 16th March and quality of fruits from the trees pruned on 31st March excelled others. The fruits harvested from the trees pruned on 31st March registered less damage by fruitfly indicating that last week of March was ideal for pruning ber.

The study has indicated that last week of March is the suitable and best time of pruning to obtain better growth, good yields, better quality and less fruitfly infested fruits under the prevailing agro-climatic conditions of Tirupati (A.P.).

Introduction

CHAPTER - I

INTRODUCTION

On account of its sylleptic branches and nature of bearing of fruits only on current season's growth, and if trees are left unpruned, they tend to prolong the vegetative growth, resulting in weak branches, reduced bearing area and finally branches become unproductive. The fruit size is also reduced considerably and the trees become unproductive wild bushes (Teaotia and Chauhan, 1963 : Vashistha and Pareek, 1978 : Kundu *et al.,* 1994; Jawadagi *et al.,* 1996). Thus regular annual pruning is essential to induce a good healthy growth of newshoots to increase the fruiting area to get good sized quality fruits and to increase the productive life of the plant.

The fruit growers of Chittoor district oflate are showing interest in the cultivation of ber. However, they lack know how of the cultivation, particularly regarding the time and method of pruning. The general recommendation for pruning in the state is May month. The weather parameters prevailing at the time of pruning and also afterwards exhibit profound influence on vegetative growth, flowering, fruiting and fruit quality. When the trees are pruned during May the incidence of fruitfly and fruit borer was found to be high. Eastern parts of Chittoor district like Tirupati receive rainfall mostly by NE mansoon during october - November and some years upto December. During this period ber fruits will be growing and developing on the tree and are vulnerable for pest and disease attack. In the earlier years high incidence of fruitfly during this period was observed leading to fruit drop and heavy losses. Hence, there is need to investigate the exact time of pruning of ber trees experimentally so as to maximise production and to minimise pest infestation.

Pruning studies on ber particularly on severity of pruning were conducted in North India (Awasthi and Misra, 1969 : Bajwa and Sarowa, 1977 ; Gupta and Singh, 1977; Lal and Prasad, 1980; Kundu *et al.,* 1995; Bharad *et al.,* 1997). However, from South India only few trials were reported (Ramadevi, 1989; Nantha Kumar and Shanmugavelu, 1991; Jawadagi *et al.,* 1996; Patil *et al.,* 1996). Further no studies on the effect of pruning (time or severity) on the incidence of pests and diseases were conducted in the country.

Hence an experiment was designed to find out the suitable time for pruning ber trees under the prevailing conditions of Tirupati with the following objectives.

1. To find out the optimum time of pruning in ber under Tirupati conditions in particular and for Chittoor district in general
2. To find out the effect of time of pruning on vegetative growth of ber plant.
3. To find out the effect of time of pruning on flowering behaviour of ber plant.
4. To find out the effect of time of pruning on fruiting behaviour of the ber plant.
5. To find out the effect of time of pruning on fruit quality of ber.
6. To observe the occurrence of different insect pests during the period of study in ber with reference to weather factors and pruning dates.

Review of Literature

CHAPTER - II

REVIEW OF LITERATURE

2.1 Pruning is one of the most ancient of horticultural practices. Pruning can be described as the removal of a part or parts of a woody plant for a specific purpose, the objective in view may be for beauty, strength, health or the quantity or quality of the fruit borne (Hayes, 1957). The deciduous trees have always been considered the ones requiring pruning, while the ever green fruits, in general are regarded as not responsive to pruning, and so do not require pruning. However a number of observations made in some species such as citrus, pomegranate, ber, guava, phalsa etc., have proved the necessity and effectiveness of pruning in maintaining the sustained fruit yield and keeping the plants within the manageable limits.

There are several reasons for pruning trees. Pruning trees soon after they are planted restores the balance between the root and shoot systems. Young trees are usually pruned in order to obtain a strong frame work, accessible for the cultural practices. Fully grown trees are pruned to maintain the canopy height, spead and density required for easy spraying, fruit thinning and harvest. However, the main reason for pruning of mature trees is to foster a high quality of yield. Pruning prevents excessive growth, increases fruit size and facilitates light penetration into the interior, which improves fruiting and colouration.

Pruning is an essential operation in the cultivation of fruit crops like grape, phalsa, ber, apple, pear, peach, etc., in which the fruits are borne on the current season's growth.

Climate has significant bearing on pruning. Different plant species, grown in different climatic zones, are required to be pruned differently depending upon the type of the plant and the specific objective the grower/horticulturist has in mind.

Several workers have studied the effect of time and severity of pruning on growth and performance of ber. However, work done under South Indian conditions is very little and no work was done regarding the effect of time of pruning on pest infestation.

As the work done on the effect of time of pruning on ber was very little, crops like grape, phalsa are also included in this review.

2.2 EFFECT OF TIME OF PRUNING

To decide the suitable time of pruning a tree, a vine or a bush, it is essential to know the growth and flowering behaviour in different climates, since the varying climatic conditions influence the growth and performance of plant species.

Ber *(Zizyphus mauritiana* Lamk) is under cultivation both in North and South India. The climate of North India differs from South India. In North India most of the area under ber falls in sub-tropical zone. While the climate of South India is tropical. Under North Indian conditions, summers and winters are severe and quite distinctive. Under South Indian conditions, the summers are hot and winters are

mild. Because of these variations in climate, the growth and flowering behaviour of ber differs in North and South India. Under South Indian conditions, growth starts early in the season and similarly flowering and fruiting are also early. Under South Indian conditions ber flowers in July-August and the fruits will come to harvest from November-December to January. On the other hand, under North Indian conditions, ber flowers in October-November and it will be in fruiting till the end of April. The tree sheds its leaves and enters into a period of dormancy, only after the completion of harvesting. Though the period of dormancy in ber differs from North to South India, the period coincides with rising atmospheric temperatures and low humidity and is completed before the onset of mansoon season. As the commencement of dormancy differs from South to North India, the time of Pruning is likely to influence the growth and fruiting of ber.

Zora Singh and Sandhu (1984[a] and 1984[b]) conducted an experiment to find out the effect of time of pruning on growth, flowering, fruit set and maturity in ber under the prevailing conditions of Ludhiana. The trees were pruned at fortnightly intervals starting from 15 April to 14 July. They found that the time of pruning did not have any significant effect on vegetative growth. Early flowering was observed incase of early pruned trees. The period of blooming was advanced by 14 days in earliest pruned trees (15 April). Early pruning resulted in early sprouting and consequently early flowering. Early pruned trees initiated more flowers per cyme than late pruned ones. The fruit set was highest when the trees were pruned on 30 May and the lowest on the trees pruned on 14 July. Fruit set was better on early pruned trees than on late pruned ones. In the early pruned trees, the flower initiation and blooming were early which resulted in early fruit maturity.

Zora Singh and Sandhu (1984a) found that the trees pruned during mid-May to mid-June resulted in higher yields and better quality fruits than earlier (15-30 April) or later (29 June - 4 July).

Under coordinated projects, trials on standardization of pruning time in ber were conducted at Bawal, Hissar, Rahuri and Aruppukottai. At Rahuri (Maharastra) trees were pruned at monthly intervals from April to July. During the first year of trial, it was reported that early pruning was effective in advancing the flowering and in increasing the yields per tree. High yields were obtained in early pruned trees but yields were decreased when trees were pruned in May and June and again rose when trees were pruned in July. The increase in yields in July pruning may be due to increase in individual fruit weight, which may be due to more water absorption, as the fruits passed their developmental period during rains. However, during second year of trial, a different trend was observed in response of ber to different dates of pruning. April pruning recorded highest yields, but unlike previous year, this year the yields decreased as the pruning was delayed. July pruning recorded the least yields. On the other hand fruit set was delayed in early prunings (Pareek 1986 and 1987).

At Hissar the ber trees were pruned at 15 days interval from 30 April to 10 June. Leaf area increased with delay in pruning. April and May prunings were more effective in influencing the bud sprouting, shoot length, fruit set, fruit retention etc. Flowering was earlier in early pruned trees. Yield per tree also increased from April pruning to 30 May pruning, but trees pruned on 14 June produced least yields (Pareek, 1987).

Gupta and Godara (1989) conducted an experiment at Hissar to study the effect of time of pruning on yield and quality of ber. The trees were pruned on April 30, May 15, May 30 and June 10. They found that shoot length and diameter, weight of pruned wood, fruit set percentage, fruit weight and length, pulp weight, pulp/stone ratio, TSS, ascorbic acid, TSS/Acid ratio increased significantly either in May 15 or in May 30 pruned trees over April 30 and June 10 pruned trees. Average number of primary buds from which secondary branches arose, acidity, stone weight and length were decreased significantly in May 15 and May 30 pruned trees. Girth of stock and scion remained unchanged with the time of pruning. Percentage of bud sprouting was also not changed by the time of pruning. Bud sprouting, flowering and fruit harvest time were delayed with the delay in pruning time. Yields were high from the trees pruned on 30 May.

Ramadevi (1989) conducted an experiment at Hyderabad, in which trees were pruned on five different dates from 15 March to 14 May. Tallest plants were noted when trees were pruned on 14 April. Early pruned (15 March) trees had maximum trunk growth. Vegetative bud sprouting was earlier in early pruned trees and it was delayed as the pruning was delayed. Longest shoots were seen on trees pruned on 14 May. Delayed pruning resulted in greater number of shoots with less number of laterals per shoot. Yields were highest from trees pruned on 14 April and least from those pruned on 15 May. She reported that the physical parameters of ber fruits were significantly influenced by the time of pruning except percentage of pulp and stone and pulp to stone ratio. Incase of chemical parameters she found the erratic response of ber trees to the time of pruning. The fruits harvested from 14 April pruned trees were found to be of good quality.

At Hisar the trees were pruned on different dates comprising of 30 April, 15 May, 30 May and 10 June. The study revealed that flowering was early in early pruned trees and there is delay in harvesting of fruits as the pruning is delayed. Highest fruit set recorded on 15th May pruned trees was significantly better than 30th April treatment and at par with 30th May ;and 10th June treatments. Fruit retention was highest in 30th may pruned trees which was significantly better than 30th April, 15th May and 10th June treatments. Highest fruit weight recorded in 15th May pruned trees was significantly higher over other pruning treatments. Maximum pulp/stone ratio was recorded in the 30th May pruned trees (Gupta *et al.*, 1990).

An experiment conducted to study the influence of time of pruning on growth, flowering, fruiting and fruit quality of ber at Ludhiana revealed that pruning done during deep dormancy phase (mid May to mid June) had significant effect on growth, yield and fruit quality. The deviation in the time of pruning from this phase of dormancy resulted in lower yields with poor quality fruits (Sandhu *et al.*, 1992).

Patil and Hulamani (1994) studied the influence of time of pruning on growth, flowering, fruit set, yield,quality and shelf life of different ber cultivars at Dharwad. Among the three different pruning periods pruning during April was better with respect to growth (shoot length, number of shoots/limb, flowering, no. of flowers/cyme, fruit set). However, the highest fruit yield was recorded in March pruning. With respect to the fruit quality the highest TSS was noticed in April pruning. The highest TSS to acid ratio, less ascorbic acid content, highest total sugars and reducing sugars were found in April pruning. The fruits obtained from the trees pruned during March had less fruit borer and fruitfly and powdery mildew incidence.

Kundu *et al.* (1994) conducted an experiment at Hissar to study the effect of time of pruning on growth, flowering and fruiting in ber. The trees were pruned on three dates, at the interval of 15 days i.e., from 15th May to 15th June. They found that the shoot length, leafarea, percent bud sprouting, percent fruit set and percent fruit retention differed significantly with various pruning treatments. The shoot length increased significantly with delay in pruning upto 30 May, but with further delay (15th June) it decreased. The maximum bud sprouting (percentage) was recorded in the trees pruned on 15th May and the minimum by pruning on 15th June. Maximum leaf area was recorded in trees pruned on 30th May and the minimum in the trees pruned on 15 May. Maximum fruit set was recorded on 30th May followed by 15th May. Maximum fruit retention was recorded in the trees pruned on 30 May which was significantly higher than 15th June. The delay in pruning also delayed bud sprouting, flowering and fruit set which resulted in slight delay in fruit harvest.

Kundu *et al.* (1995) conducted an experiment to study the effect of time of pruning on physico-chemical characteristics and yield of ber. The trees were pruned on 15th , 30th May and 15th June. They found that highest fruit weight and pulp/stone ratio and lowest stone weight, highest fruit total soluble solids and ascorbic acid contents and lowest acidity were recorded in the fruits from trees pruned on 30 May. Highest yield was also recorded by the 30th May pruned trees.

Jawadagi *et al.* (1996) conducted an experiment in farmer's field at sulla village, Karnataka to study the effect of time of pruning on growth, flowering, fruit set, fruit retention, yield and quality parameters of ber. They found that among the parameters studied early pruned trees (15th May) recorded more number, longer length of shoots, higher fruit set, fruit retention and weight of fruits resulting in higher yields compared to rest of the treatments (30th May and 15th June). While quality aspects of fruits are concerned, later pruned (15th June) trees recorded higher vitamin C, and acidity compared to early or mid pruning periods.

Bharad and Tayde (1997) conducted an experiment at Akola to study the effect of time of pruning on growth, flowering, fruit set, yield and quality in different ber cultivars. The trees pruned on 25th March exhibited greater growth and higher quality, and yield in all the varieties. Maturity of fruits was affected significantly by pruning time. Fruits from trees pruned on 25th March, matured early and attained better quality in all the fruits.

Grape is another fruit which requires pruning for inducing fruitfulness and it responds markedly to time of pruning.

Parthasarathy Redddy and Satyanarayana (1970) studied the effect of time of pruning on growth, flowering, yield and quality of Anab-e-shahi grape under the prevailing conditions of Hyderabad. The vines were pruned at 10 day intervals between September 20th and November 20th. They reported maximum shoot growth when the vines were pruned on 20th October and gradual decline with the delay in pruning time. The earliest panicle emergence was observed in early pruned vines. Similarly maximum yields were obtained from october prunings.

Studies (Patil, 1975) conducted to find optimum date of pruning of Anab-e-shahi under Akola conditions (Maharastra), revealed that maximum bud burst, shoot growth and yield were obtained from those pruned on 1st october. Patil (1975) recorded less yields with vines pruned very early or very late in the season. Incase of late pruned (November) vines, the reduced bud burst, shoot growth and fruiting area were attributed to fall in temperatures and reduced yields were due to reduced bud burst, shootlength and fruiting area (Patil, 1975).

Shinde and Rane (1979) studied the effect of time of pruning on growth, production and quality of Bangalore Purple grapes under Nagpur conditions. Higher bud burst, higher number of bunches, greater bunch weight, higher yields, with greater berry weight and increased juice percentage were observed when the vines were pruned on 5th October than those vines pruned on 20th October.

Investigations were made at Bangalore on the effects of time of pruning on Thompson seedless grapes to improve bud burst, vegetative growth, yield and quality of fruits (Deoju, 1983). The vines pruned in October resulted in highest percentage of bud burst, while pruning on 14th November resulted in the lowest bud burst. The vines pruned on 30th October, gave highest number of clusters and yield with larger sized berries. While weight and volume of 100 berries were more in vines pruned on 15th october, the yield was reduced due to delayed pruning. Availability of grapes was extended over a period of 45 days from 16th March to 30th April due to staggered pruning.

Studies were conducted in USA on the effect of time of pruning on Muscadine and Bunch grape cultivars. Five Muscadine (*vitis rotundifolia*) and 3 bunch (hybrid) grape cultivars were pruned in the autumn (A) of 1986 and in the winter (W) and spring (S) of 1987. Pruning weights were highest from Muscadine cultivars pruned in winter and from bunch cultivars pruned in Autumn. Autumn pruning advanced bud swelling, bud break, flower bud formation, flowering and berry set, compared with winter or spring pruning. Grape yields/vine of Autumn pruned Muscadine cultivars were significantly higher than those from winter or spring pruned vines. No consistent pattern was observed for grape yields and Brix of bunch cultivars in relation to pruning time (Onokpise and Inyang, 1987).

Studies were conducted at Dharwad, Karnataka on the effect of time of pruning in vinifera grape cultivars. Back pruning was done on four different dates from 15 March to 29 April at fortnightly intervals. The first fortnight of April appeared to be the appropriate time for pruning the vines under Dharwad conditions with regard to growth and yield attributes (Bhat and Hulamani, 1994).

According to Heyes (1957) late December or early January is the best time for pruning the phalsa bushes under North Indian conditions as the pruning in early December kills the new growth by frost.

Singh and Sharma (1961) recorded maximum yield when phalsa bushes were pruned on 10th January where as bushes pruned on 20th December and 10th February resulted in less yields under Delhi conditions. They recorded decreased number of days for sprouting, flowering, first picking and also for the completion of crop with delay in pruning from 20th December to 10 February. According to them, fruit quality was not affected by different dates of pruning. They found non-significant response regarding height and spread of the bushes.

Singh (1974) from Hissar reported that bushes pruned during middle of January gave maximum yield with good quality fruits.

Shinde *et al.* (1976) made investigations on the response of two year old phalsa bushes under Parbhani (Maharastra) conditions. Maximum number of newshoots per pruned stem were noted when the bushes were pruned in January. Maximum yields were also reported from the bushes pruned during 1st week of January.

Naram Naidu (1987) studied the effect of time of pruning on growth, flowering and fruiting and yield of phalsa bushes at Hyderabad. Bushes were pruned at 15 days interval from 1st November to 16th January. Time of pruning had significant influence on some of the growth parameters. He found non-significant response regarding the tree height and tree spread. Sprouting and flowering were earlier whereas days to first picking and total crop duration were decreased with delay in time of pruning. Bushes pruned on 1st January produced maximum number of shoots and had maximum percent fruiting area. More number of fruits per node as well as higher yields were observed in 1st January pruned bushes. However, fruit quality is not affected appreciably by the time of pruning.

Janardhan Rao and Rama Krishna Reddy (1989) conducted an experiment to study the effect of time of pruning on yield of phalsa. The plants were pruned on 6 dates at 15 days intervals starting on 1 Nov. They found that pruning on 1st January, significantly increased the number of new shoots and fruiting area over other pruning dates. This may be attributed to favourable temperatures for the bud bursting and development of new shoots resulting in more fruiting area. Higher yields were obtained with the plants pruned on 1st January. They were significantly superior to other dates of pruning.

Materials & Methods

CHAPTER - III

MATERIALS AND METHODS

The present investigation entitled "Studies on the effect of time of pruning on Ber (*Zizyphus mauritiana* Lamk) under Tirupati (Andhra Pradesh) conditions" was carried out at S.V.Agricultural College, Tirupati during March 1998 to December 1998.

3.1 LOCATION AND CLIMATIC CONDITIONS

Tirupati is located in the Southern agro climatic zone of Andhra Pradesh and falls under semi-arid tropics (SAT) (Troll, 1958) and is situated at an altitude of 182.9 meters above mean sea level on 79° E longitude and 13°N latitude. The meteorological data, recorded in respect of rainfall, maximum and minimum temperatures sunshine hours and relative humidity are presented in Appendix - I.

During the period of study a total rainfall of 1045.6mm was received in 66 days. The weekly mean maximum and minimum temperatures ranged from 42.4°C to 26.4°C and from 29.4°C to 16°C respectively. The relative humidity at 7.16 hours and 14.16 hours ranged from 93% to 51% and from 84% to 31% respectively. Mean sunshine hours ranged from 10.9 to 0.8.

3.2 SOIL

The Soil is sandy clay with low organic carbon, low phosphorus (4kg/ha) and low potassium (145kg/ha) levels and with a PH of 8.0.

3.3 DETAILS OF THE BER PLANTS

The ber trees were planted on sandy clay soil in January, 1988, at spacing of 6X6m. Healthy and uniform trees of variety Gola were selected for the study.

3.4 EXPERIMENTAL DETAILS

The experiment was laidout in RBD with dates of pruning as treatments, replicated four times. The trees were pruned at 15 days interval starting from 1st March to 30th April, as follows :

Treatments:

D_1 - 1st March, 1998

D_2 - 16th March, 1998

D_3 - 31st March, 1998

D_4 - 15th April, 1998

D_5 - 30th April, 1998

The trees were pruned depending upon the vigour of the branches to 4-6 nodes from the base. Each treatment in a replication includes four trees, making a total of 80 trees.

3.5 IMPOSITION OF TREATMENTS

Healthy and uniform trees of variety Gola were selected and were pruned using secateurs and hand saw, giving a straight cut at 4-6 nodes level from the base. The cut ends were smeared with copper fungicide (Blitox) as a prophylactic measure against entry of pathogens and pests. All dried and weak shoots were also removed by pruning.

Table - 1 : Dates of pruning as treatments

Treatment	Date of Pruning
D_1	01-3-1998
D_2	16-3-1998
D_3	31-3-1998
D_4	15-4-1998
D_5	30-4-1998

3.6 CULTIVATION DETAILS

The pruned trees were fertilized with NPK @ 250gm/tree through the application of 1.47 kg. of 17:17:17 immediately after pruning. The applied fertilizers were broadcast in the basin and incorporated into the soil by light digging and the trees were irrigated immediately. Subsequent irrigations were given as per the need of the crop depending upon the rainfall distribution.

The field was maintained weed free throughout the study by frequent manual weedings. No control measures were taken up against pests and diseases.

3.7 HARVESTING

At *colour break* stage, when the green colour turned to greenish yellow, the fruits were harvested at weekly intervals.

3.8 OBSERVATIONS

3.8.1 Tree Characters

3.8.1.1 **Tree height** : Tree height was measured in cms from the base of the trees upto the tip of the highest branch before pruning and after completion of harvesting with a pole marked with cms and averages were worked out.

3.8.1.2 **Trunk girth** : Girth of the tree trunk at a height of about 15 cm from the base was measured in cms with a tape, before pruning and after completion of harvesting and averages were worked.

3.8.1.3 **Tree spread** : The spread of the trees was measured in N-S and E-W directions at the time of harvesting and the average spread of a tree was calculated by the formula:

$$\frac{(N\text{-}S) + (E\text{-}W)}{2}$$

3.8.2 Vegetative Growth

3.8.2.1 Days to vegetative bud sprouting

The number of days taken for the sprouting of vegetative buds on the pruned branches, from the date of pruning were counted and recorded as the days to sprouting of vegetative buds.

3.8.2.2 Number of new shoots per tree:

Total number of new shoots borne on each tree was counted at 15 days interval from the date of sprouting of buds until flowering and averages were worked out.

3.8.2.3 Length of new shoots (cm)

On each tree five newshoots were selected randomly and the length of these selected new shoots was measured from the base to the tip of the shoots at 15 days interval starting from the sprouting of the buds until flowering. Average shoot length was worked out and expressed in cms.

3.8.2.4 Number of twigs per shoots

At 15 days interval from the sprouting of buds until flowering, total number of twigs on 5 randomly selected shoots were counted and averages was worked out.

3.8.3 Flowering

3.8.3.1 Days to flowering

Number of days taken from the date of pruning to the opening of first flower on 5 randomly tagged shoots on each tree were counted and presented as days to flowering.

3.8.3.2 Number of flower clusters (cymes) per shoot

At 15 days interval from the appearance of flower clusters to fruiting the number of flower clusters on five randomly selected shoots were recorded and the averages were worked out.

3.8.3.3 Number of flowers per cluster

The number of flowers in each cluster on five randomly selected shoots about 45cm from the tip of the shoot was counted at 15 days interval from the appearance of flowers to fruiting and the averages were worked out.

3.8.4 Fruiting

3.8.4.1 Days to first picking

Number of days taken from the date of pruning to the first picking of the fruits on each tree was counted and the averages were arrived.

3.8.4.2 Yield per tree (kg)

The total weight of all the fruits harvested at intervals from each tree in each treatment were recorded by weighing them on an Avery field balance and the averages were worked out and expressed in kg. per tree.

3.8.5 Fruit Quality

From each treatment in a replication 100 fruits at random were selected as a sample for recording the observations on physico-chemical parameters.

3.8.5.1 *Physical parameters*

3.8.5.1.1 Volume of the fruit (cc)

Volume of the fruit was measured by water displacement method and expressed as cc.

3.8.5.1.2 Length and Diameter of the fruit

Length and Diameter of each fruit in a sample of 100 fruits in each treatment were measured with vernier calipers and the means were calculated and expressed in cms.

3.8.5.1.3 Fruit weight (g)

All the 100 fruits from each treatment were weighed and the resultant weight was devided by number of fruits to arrive at mean weight per fruit.

3.8.5.1.4 Pulp weight (g)

The pulp from all the 100 fruits in a sample from each treatment was carefully removed and weighed and the same was devided by the number of fruits to get mean weight of pulp per fruit in grams.

3.8.5.1.5 Stone weight

The weight of the seed was obtained by substracting the weight of pulp from the weight of the fruit.

3.8.5.1.6 *Percentage of pulp*

Percentage of pulp was calculated using the following formula

$$\text{Percentage of fruit pulp} = \frac{\text{(Fruit weight - Seed weight)}}{\text{Fruit weight}} \text{ X } 100$$

3.8.5.1.7 Percentage of seed

The percentage of pulp was substracted from 100 to obtain the corresponding seed percentage.

3.8.5.1.8 Pulp to stone ratio

By deviding the pulp weight with stone weight the ratio was arrived.

3.8.5.2 Chemical parameters

3.8.5.2.1 Total soluble solids

The T.S.S was determined by a hand refractometer (range 0-32%) immediately after harvesting of the fruits and expressed in percentage.

3.8.5.2.2 Titrable acidity

The acidity was estimated by titrating 10ml of the fruit juice against O.1N sodium hydroxide using phenophthelein as indicator, with the relationship that 1ml of *O.1N* sodium hydroxide is equal to 0.0064g. of anhydrous citric acid (A.O.A.C. 1980) and expressed in percentage.

3.8.5.2.3 Brix to acid ratio

This is arrived by deviding brix value by acidity.

3.8.5.2.4 Ascorbic acid (Vitamin-C) Content (mg/100g of pulp)

Ascorbic acid present in the fruits was estimated in terms of mg. of ascorbic acid per 100g. of fruit, using the method described by Ranganna (1977).

Ten grams of the sample was ground and blended with 3% HPO_3 and made upto 100ml with HPO_3. The content after shaking well were filtered through Whatman No.1 filter paper. 10ml of filtrate was titrated against standard dye solution of 2,6 - dichlorophenol indophenol till the light pink colour persisted for atleast 15 seconds.

3.8.5.2.5 Total sugars (%)

The percentage of total sugars was estimated by A.O.A.C., method (1969). Twenty ml of juice was taken into 100ml conical flask and 20ml of distilled water was added and then 5ml of 6N Hcl was also added to conical flask, and kept in a hot water bath at 70°C for exactly eight minutes. After expiry of the time, the flask was removed and cooled to room temperature. The phenophthelein indicator was added followed by 40 percent sodium hydroxide solution drop by drop till the excess of acidity was neutralised. This was indicated by the formation of pink colour. Then the solution was made upto the mark in a 100ml volumetric flask by adding distilled water. This solution was taken into a beurette and was titrated against 10ml of Fehling's solution (A+B) in hot condition, using methylene blue as indicator till the brick red developed and prespitate is formed. The percentage total sugars was estimated by using the factor 10ml of Fehlings solution = 0.05g. glucose.

3.8.5.2.6 Reducing sugars (%)

The titre-metri method of Lane and Eynon described by Ranganna (1977) was adopted for estimation of reducing sugars.

A known amount of juice was taken in a volumetric flask and 2ml of 45 percent basic lead acetate solution was added for clarification. After 10 minutes, the solution was deleaded by adding potassium oxalate crystals in excess (added till excess of crystals remained undissolved) and the volume was made upto a known amount with distilled water and filtered through Whatman No.1 filter paper.

Filtrate was taken in a beurette and titrated against boiling Fehlings mixture (A+B) till the blue colour faded. Then 1ml of methylene blue indicator (1%) was added and the titration continued till the contents attained a brick red colour. Titre value is noted. Percentage reducing sugars was calculated by using the formula.

$$\text{Reducing Sugars (\%)} = \frac{\text{Glucose equivalent 0.05 X Total Volume made up}}{\text{Titre}} \times \frac{100}{\text{Weight of the Juice}}$$

3.8.6 *Incidence of the Pests*

Infestation of different pests on the ber was recorded throughout the crop period and percentage infestation of fruitfly was calculated by taking a sample of 100 fruits from each replication in a treatment at each picking and averages were worked out.

3.9 STATISTICAL ANALYSIS

The data were analysed by the method of analysis of variance outlined by Panse and Sukhatme (1967). Statistical significance was tested by 'F' value at 5 percent of probability. Critical differences at 0.05 level were worked out for the effects which were significant. The results have been depicted graphically wherever necessary.

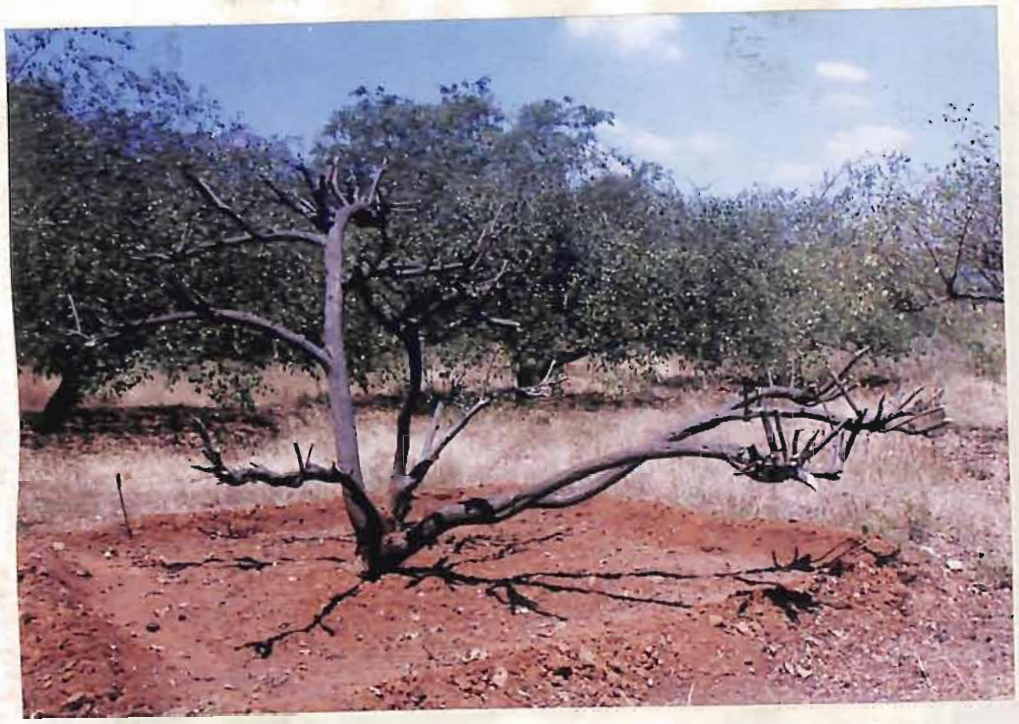

Plate.1. Ber tree on the day of pruning.

Plate.2. Ber tree growth after 15 days of pruning.

Plate.3. Ber tree growth after 30 days of pruning.

Plate.4. Ber tree growth after 45 days of pruning.

Platte.5. Ber tree growth after 60 days of pruning.

Results

CHAPTER - IV

RESULTS

The experimental findings of the present investigation on the effect of time of pruning on ber are presented in this chapter.

4.1 TREE CHARACTERS

4.1.1 Height of the tree (cm)

Observations on tree height recorded at the time of pruning and at harvest are presented in Table - 2.

It is clear from the table that there is no significant difference between the treatments with reference to tree height, at the time of pruning and at harvest. Maximum height of 410.00 cm was recorded with third date (31 March) of pruning at harvest closely followed by other dates of pruning. Trees pruned on second date (16 March) were the shortest ones with a height of 375.00cm.

However, the percentage increase in height at harvest over the height recorded after pruning was maximum with first date (1 March) and is followed by third date (31 March) of pruning while least percentage of increase was noted with the trees pruned on second date (16 March), which is followed by fourth date (15 April) and fifth date (30 April).

Table - 2 : Effect of time of pruning on tree height (cm) of ber trees

Treatment	Before Pruning	At Harvesting	% increase
D_1	291.25	388.75	33.47
D_2	303.75	375.00	23.45
D_3	312.50	410.00	31.20
D_4	301.25	377.50	25.31
D_5	316.25	401.25	26.87
S.E.	22.99	27.67	5.17
C.D (0.05)	50.10	60.31	11.26

Table - 3 : Effect of time of pruning on trunk girth (cm) of ber trees

Treatment	Before Pruning	At Harvesting	% increase
D_1	61.87	75.10	21.38
D_2	69.37	78.57	13.26
D_3	58.50	63.27	8.15
D_4	60.92	71.20	16.87
D_5	70.25	79.37	12.98
S.E.	11.08	11.60	3.89
C.D (0.05)	24.15	25.29	8.48

4.1.2 Girth of the tree (cm)

The data on the girth of the tree trunk were presented in Table - 3.

It is evident from the table that there is no significant difference between the different pruning dates, at the time of pruning and at harvest. The girth was maximum (79.37cm) with fifth date of pruning and least (63.27cm) with third date of pruning. Other pruning dates recorded intermediate values. The percentage increase of trunk girth was significant and was highest in earliest pruned trees followed by those pruned latest. Least increase in girth was recorded in trees pruned on third date of pruning (D_3).

4.1.3 Tree spread (mt)

Tree spread was not influenced by dates of pruning (Table - 4). The differences between dates of pruning failed to reach a level of significance. However, the tree spread was maximum (3.86mt) in trees pruned last and least (3.19mt) in earliest pruned trees.

4.2 VEGETATIVE GROWTH

4.2.1 Days to vegetative bud sprouting

The data recorded on number of days taken by the pruned trees for sprouting of dormant buds in ber, in response to different dates of pruning are presented in Table - 5. It is seen from the data that the early pruned trees sprouted early and the sprouting was delayed as the pruning was delayed.

Table - 4 : Effect of time of pruning on tree spread (mt) of ber trees

D_1	D_2	D_3	D_4	D_5	S.E.	C.D. (0.05)
3.19	3.26	3.70	3.78	3.86	0.60	1.48

Table - 5 : Effect of time of pruning on days to vegetative bud sprouting

S.No.	Days to Vegetative bud sprouting
D_1	17
D_2	19
D_3	20
D_4	22
D_5	22
S.E.	0.81
C.D (0.05)	1.77

A further perusal of the data indicates significant influence of pruning dates on the number of days to sprouting of vegetative buds on the pruned trees. It is clear from the table that the first pruned trees (D_1 - 1 March) have taken significantly least number of days (17) for sprouting and the treatment is superior to all other dates of pruning. There is no significant difference between D_2 (16 March) and D_3 (31 March) which took 19 and 20 days respectively for sprouting. On the other hand D_4 (15 April) and D_5 (30 April) pruning dates took maximum number of days (22 days) for sprouting of vegetative buds.

4.2.2 Average number of new shoots per tree

Total number of new shoots borne on each tree were recorded at 15 day intervals and presented in Table - 6.

From the table it is clear that there is not significant difference between the treatments at all the days after sprouting (DAS) but it markedly influenced the production of new shoots on pruned trees. The number of shoots has progressively rised from 15 days after sprouting (DAS) to 60 DAS irrespective of time to pruning. On any date of observation, the number of shoots was maximum on late pruned trees. However, the dates of pruning did not differ statistically among themselves in the production of new shoots per tree. At 60 DAS maximum number (305.5) of shoots was obtained with D_5 and minimum number (253.00) was recorded by D_3.

4.2.3 Length of new shoots (cm)

Observations on shoot growth recorded at 15 day intervals as influenced by different dates of pruning are presented in Table - 7.

Table - 6 : Effect of time of pruning on average number of new shoots per tree of ber

S.No.	15 DAS	30 DAS	45 DAS	60 DAS
D_1	52.50	142.25	199.75	277.75
D_2	55.75	147.25	224.50	282.75
D_3	58.75	125.75	175.25	253.00
D_4	59.50	117.25	189.75	264.50
D_5	70.50	159.00	237.25	305.50
S.E.	11.51	19.86	28.63	36.10
C.D (0.05)	25.08	43.28	62.38	78.66

Table - 7 : Effect of time of pruning on length of new shoots (cm) of ber

S.No.	15 DAS	30 DAS	45 DAS	60 DAS
D_1	69.75	115.75	169.25	212.75
D_2	49.50	90.50	128.75	169.00
D_3	58.75	110.50	157.50	202.75
D_4	58.25	117.75	157.75	203.75
D_5	61.00	115.00	160.75	235.00
S.E.	8.20	11.47	12.24	8.51
C.D (0.05)	17.88	25.00	26.68	18.54

The data on the length of new shoots under different pruning treatments show that there is significant difference between the treatments. There was a progressive increase from 15 to 60 days after sprouting (DAS). At 15 DAS, Maximum length of new shoots (69.75cm) and minimum (49.50 cm) were recorded in the treatments D_1 and D_2 respectively. At 30 DAS, maximum shoot length (117.75 cm) obtained in D_4 and minimum (90.50cm) in D_2 pruning dates. There is no significant difference between D_1,D_3,D_4 and D_5 at 30 DAS. At 45 and 60 DAS the trend has changed. At 45 DAS the treatment D_1 recorded maximum (169.25cm) shoot growth and treatment D_2 recorded minimum (128.75cm) shoot growth. At 60 days after sprouting (DAS) shoot length was recorded maximum (235.00cm) in D_5 and minimum (169.00cm) in D_2 and there is no significant difference between the treatments D_1,D_3 and D_4 at 60 DAS.

4.2.4 Average number of twigs per shoot

The mean numbers of twigs per shoot as influenced by different dates of pruning are shown in Table - 8. The data indicate the significant influence of time of pruning. It is seen from the table that number of twigs has progressively increased from 15 DAS to 60 DAS irrespective of time of pruning.

It is clear from the data that at 15 DAS, the number of twigs per shoot has progressively decreased from D_1 to D_5. Same trend was followed at all the DAS. At 60 DAS highest number of twigs was observed (10.30) in D_3 which was onpar with D_1 and least in D_5 treatment and D_2 and D_4 were onpar with each other.

Table - 8 : Effect of time of pruning on average number of twigs per shoot of ber

S.No.	15 DAS	30 DAS	45 DAS	60 DAS
D_1	4.50	6.25	8.40	10.15
D_2	3.55	5.40	7.10	8.75
D_3	4.25	7.20	8.05	10.30
D_4	3.70	6.00	7.55	8.90
D_5	2.95	5.15	6.20	7.85
S.E.	0.31	0.33	0.41	0.57
C.D (0.05)	0.69	0.72	0.90	1.25

Table - 9 : Effect of time of pruning on date and days to flowering of ber

S.No.	Date of flowering	Days to flowering
D_1	29.4.1998	60
D_2	19.5.1998	65
D_3	10.6.1998	72
D_4	22.6.1998	69
D_5	09.7.1998	71

4.3 FLOWERING

4.3.1 Days to flowering

Number of days taken from the date of pruning to the opening of first flower on 5 randomly tagged shoots were counted and is presented in Table - 9.

The time taken for flowering varied from 60 to 72 days in different treatments. Early pruned trees flowered earlier. Treatment D_1 took less number of days (60 days) to flower and is followed by D_2 (65days), D_4 (69 days), D_5 (71 days) and D_3 (72 days).

4.3.2 Number of flower clusters (cymes) per shoot

The data on mean number of flower clusters (cymes) per shoot on pruned trees under different dates of pruning, recorded at 15 day intervals from the respective date of flowering are furnished in Table - 10.

Pruning at different dates has significantly influenced the production of number of cymes on new shoots. The number has progressively increased from the date of flowering to 75 days after flowering (DAF) and declined by 90 DAF.

At 15 DAF the number of cymes was maximum (74.60) on trees pruned on 1st March and minimum (41.35) on trees pruned on 16th March, which differed statistically. The pruning dates viz., 1st March and 31st March were onpar.

At 30 DAF the trend has changed. The number of flower clusters per shoot was highest (130.70) with 31 March pruning and least (95.50) with 16th March pruning and they differed statistically. The pruning dates viz., 1st March, 15th April and 31st March however, were on par.

Table - 10 : Effect of time of pruning on number of flower clusters per shoot of ber

S.No.	15 DAF	30 DAF	45 DAF	60 DAF	75 DAF	90 DAF
D_1	74.60	119.40	190.60	261.55	314.05	111.40
D_2	41.35	95.50	151.05	245.30	299.00	104.80
D_3	70.30	130.70	193.75	258.75	322.70	105.90
D_4	62.75	116.90	176.20	235.05	307.30	105.65
D_5	51.50	96.10	159.80	262.80	310.90	102.20
S.E.	8.64	7.12	4.27	3.90	4.96	2.30
C.D (0.05)	18.82	15.52	9.32	8.51	10.82	5.00

Table - 11 : Effect of time of pruning on number of flowers per cluster of ber

S.No.	15 DAF	30 DAF	45 DAF	60 DAF	75 DAF	90 DAF
D_1	8.90	11.15	12.20	12.70	13.95	7.35
D_2	8.05	9.95	12.15	13.35	14.55	7.20
D_3	9.95	11.20	13.20	15.40	16.25	6.80
D_4	7.40	8.65	10.75	12.95	14.60	8.10
D_5	9.25	11.55	13.10	13.75	14.85	8.15
S.E.	0.34	0.31	0.35	0.36	0.43	0.51
C.D (0.05)	0.75	0.68	0.76	0.79	0.95	1.12

At 45 DAF the number of flower clusters per shoot was highest (193.75) with 31st March pruning and least (151.05) with 16th March pruning and they differed statistically. Pruning dates viz., D_1 and D_3 were onpar with each other.

At 60 DAF, least (235.05) and highest (262.80) number of flower clusters were counted on trees pruned on 15th April and 30th April respectively. Pruning dates viz., 1st March, 31st March and 30th April were onpar. Subsequently at 75 DAF, maximum (322.70) and minimum (299.00) number of flower clusters were recorded with 31st March and 16th March prunings.

Finally at 90 DAF once again the pattern has changed giving first position to 1st March pruning and last position to 30th April pruning, which differed statistically.

4.3.3 Number of flowers per cluster

The observations on number of flowers per cluster recorded at 15 days interval are presented in Table - 11. The production of flowers per cyme responded significantly to different dates of pruning. At 15 DAF, the flower clusters had maximum (9.95) and minimum (7.40) number of flowers on trees pruned on 31st March and 15th April respectively and they differed statistically. At 30 DAF the trend has changed, maximum number of flowers (11.55) were counted with 30th April pruning and minimum number of flowers (8.65) counted with 15th April pruning. At 30 DAF 1st March, 31st March and 30th April pruning treatments were on par. At 45 DAF, the maximum number of flowers (13.20) per cluster were counted with 31st March pruning and minimum number of flowers (10.75) per cluster counted with 15th April pruning. At 45 DAF, 31 march and 30th April

Table - 12 : Effect of time of pruning on date and days to first picking of ber

S.No.	Date of first picking	Days to first picking
D_1	14.11.98	258
D_2	22.11.98	251
D_3	23.11.98	237
D_4	2.12.98	231
D_5	6.12.98	220

Table - 13 : Effect of time of pruning on yield per tree (kg) of ber

S.No.	Kilograms
D_1	21.07
D_2	17.02
D_3	60.25
D_4	41.32
D_5	19.72
S.E.	2.42
C.D (0.05)	5.28

pruning treatments were onpar with each other. At 60 and 75 DAF, the pattern has changed, least number of flowers (12.70 and 13.95) were counted with 1st March pruning and highest number of flowers (15.40 and 16.25) were counted with 31st March pruning and they differed statistically. At 90 DAF, late pruning (30th April) resulted in the production of maximum number (8.15) of flowers per cluster.

4.4 FRUITING

4.4.1 Days to first picking

Number of days taken from the date of pruning to the first picking of fruits was counted and presented in Table - 12.

From the table it is clear that early pruned trees came to early maturity of the fruits compared to all other treatments. The fruits matured much earlier (14th November) on early pruned trees where pruning was done on 1st March. This was followed by subsequent pruning dates and the fruits matured as late as on 6th December on the trees pruned very late (30th April).

When the number of days passed from the date of pruning to first picking was considered, it is observed that the late pruned (30th April) trees have taken less numbers of days (220) to first picking while first pruned trees (1st March) took longer time (258 days) to first picking. While the rest of the dates registered intermediate duration.

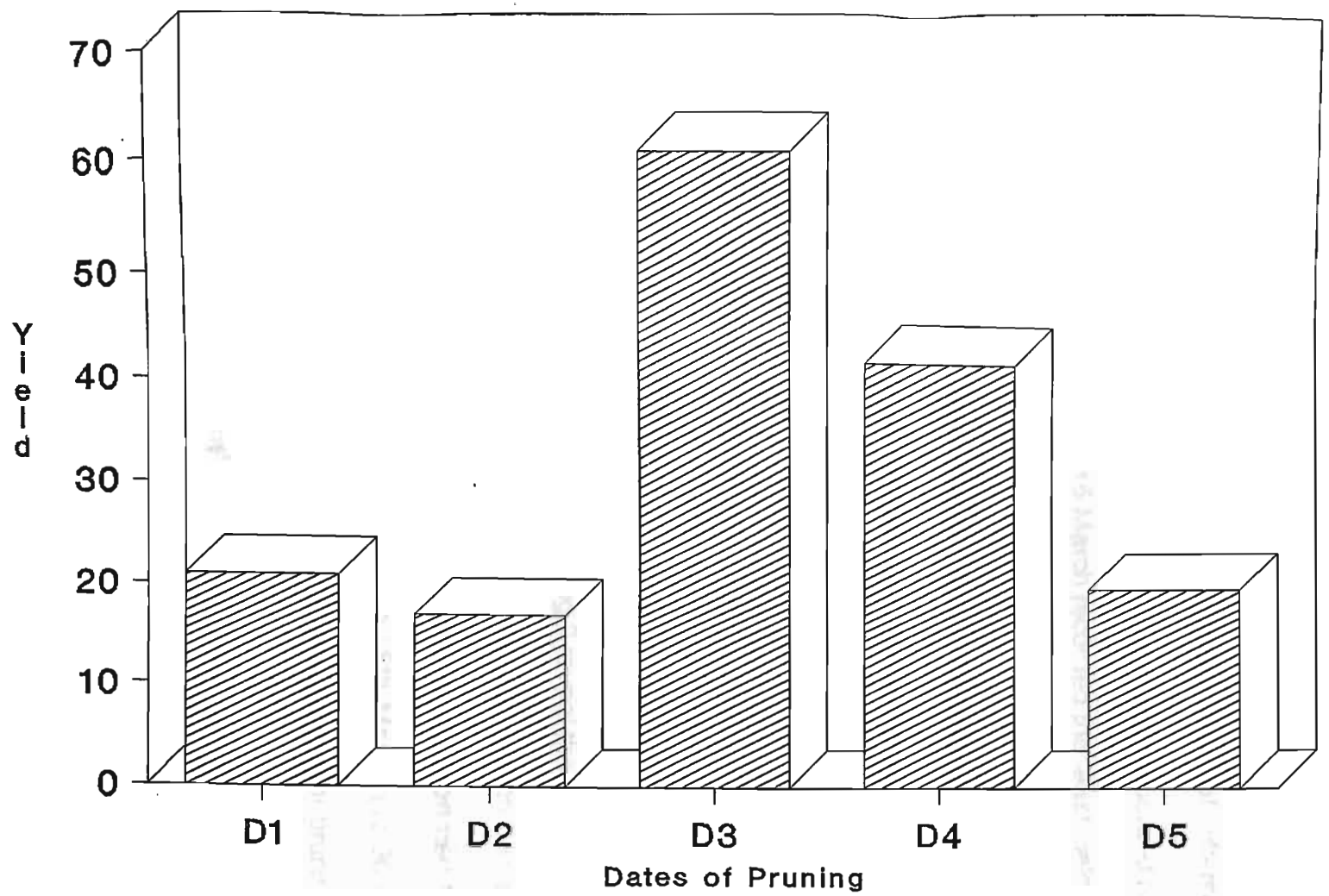

Fig.1 Effect of time of pruning on the Yield per tree (Kilograms) of ber

4.4.2 Yield per tree (kg)

The data on yield per tree were recorded and presented in Table - 13 and Fig.1.

A perusal of the data indicates significant influence of different dates of pruning on the fruit yield. The trees pruned on 31st March recorded highest yield (60.25 kg.) and the trees pruned on 16 March recorded the least yield (17.02 kg.). The rest of the pruning periods recorded intermediate values. Pruning on 1st March, 16th March and 30th April was onpar, but differed from other two dates. *Pruning* dates D_4 and D_3 were statistically independent of each other.

4.5 FRUIT QUALITY

4.5.1 Physical Characters

4.5.1.1 Volume of the fruit (cc)

The data presented in Table - 14 and Fig-3 reveal that the dates of pruning had marked influence on this parameter. The fruits of 31 March pruned trees had maximum volume (22.40cc) followed by those of 30th April pruned trees (20.85 cc). While the least volume was registered with 16th March (16.90 cc) pruning. Statistical differences were noted among the different dates of pruning.

4.5.1.2 Length of the fruit (cm)

The observations noted inrespect of length of fruit under individual treatments are presented in Table - 14 and Fig-2. The length of the fruit was significantly influenced by the time of pruning. The fruits of 31 March pruned trees

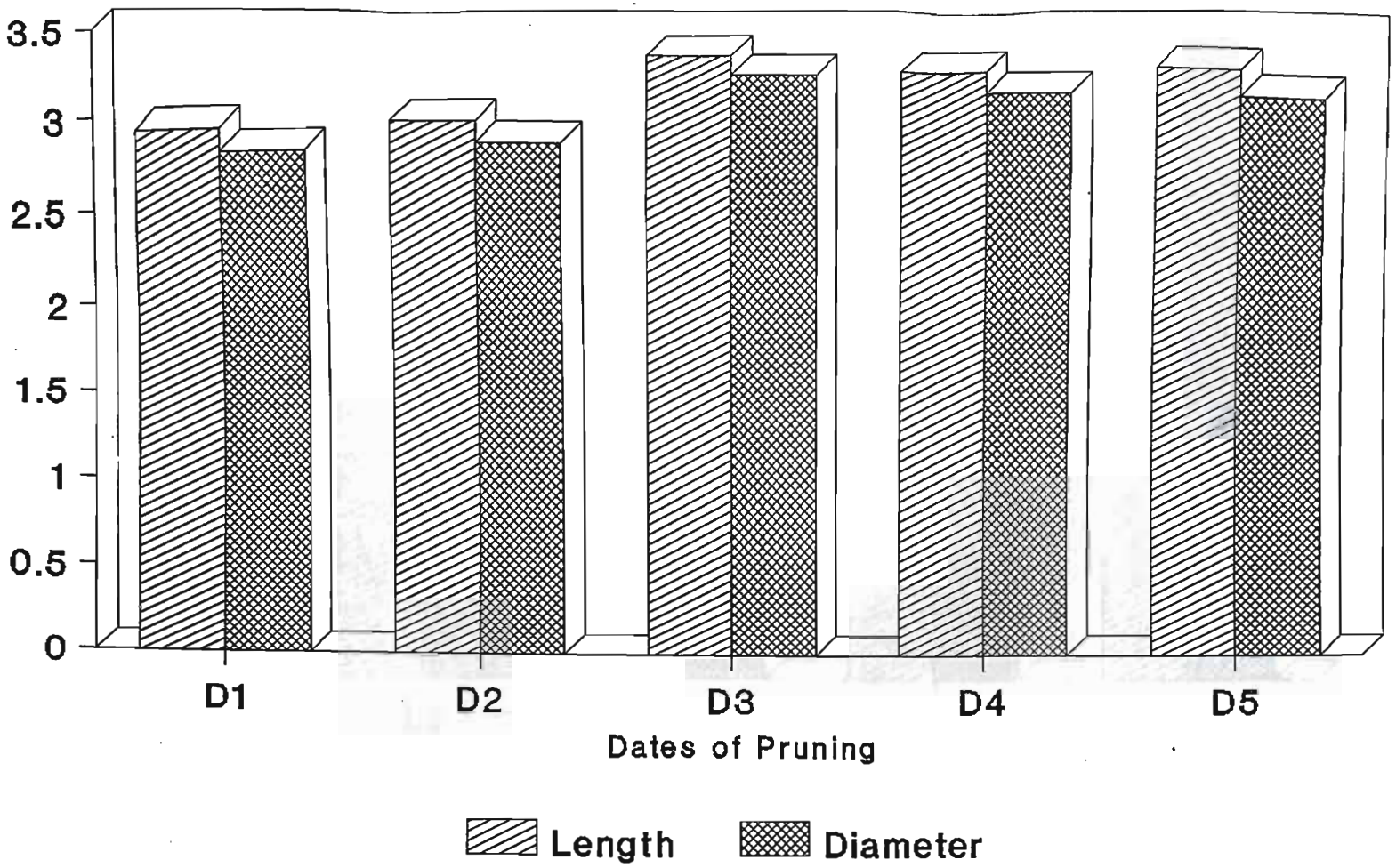

Fig.2 Effect of time of pruning on length (cm) and diameter (cm) of the ber fruits

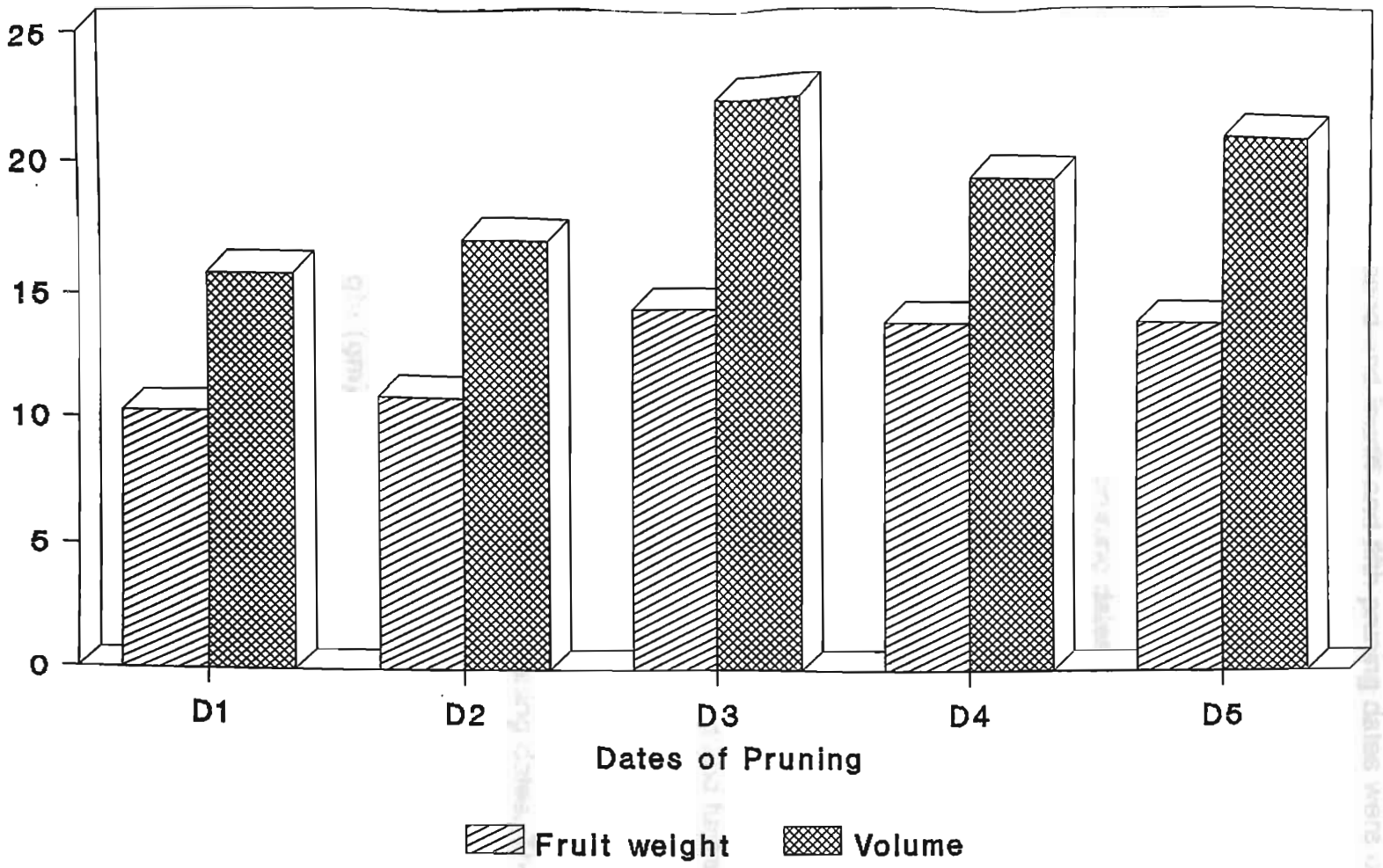

Fig.3 Effect of time of pruning on Weight (gm) and Volume (cc) of the ber fruits

recorded maximum length (3.35cm) while the minimum length (2.93cm) was recorded with 1st March pruned trees and they differed significantly from each other. First and second and fourth and fifth pruning dates were onpar

4.5.1.3 Diameter of the fruit (cm)

The data noted inrespect of diameter of the fruit are presented in Table-14 and Fig-2. Significant influence of pruning dates on the diameter of the fruit was observed. Maximum (3.23cm) and minimum (2.80) diameter of fruits were measured in fruits of trees pruned on 31st March and 1st March respectively. The treatments D_1 and D_2 and D_4 and D_5 were of same order.

4.5.1.4 Fruit weight (gm)

The data pertaining to fruit weight were recorded and furnished in Table-14 and Fig-3. The influence of pruning time on fruit weight was significant. Fruits borne on trees pruned on 31st March recorded highest fruit weight (14.40 gm) which was statistically significant with all other pruning dates. The treatments D_1 and D_2 and D_4 and D_5 were of same order.

4.5.1.5 Pulp weight (gm)

The weight of pulp ranged from 9.08g (D_1) to 13.08g (D_3) under the influence of different dates of pruning (Table-14). Maximum and minimum weights of pulp were noted in fruits of 31st March and 1st March respectively. The third, fourth and fifth pruning dates were of same order.

4.5.1.6 Stone weight

The data in Table-14 indicate that the stone weight was least (1.18g) in fruits of trees pruned on 16th March and it was maximum (1.32g) in fruits of trees pruned on 31st March. The treatments D_1, D_2, D_3, D_4 and D_5 were onpar. The difference between the highest and lowest values of stone weight was 0.14g only.

4.5.1.7 Percentage of pulp

The data pertaining to percentage of pulp were recorded and presented in Table-14. The highest percentage of pulp was (90.90%) recorded with the fruits of trees pruned on 15th April and least was (88.32%) recorded in fruits of trees pruned on 1st March. The second, third, fourth and fifth dates of pruning were of same order.

4.5.1.8 Percentage of seed

Data presented in Table-14 reveal significant difference between the treatments. Maximum (11.68%) percentage of seed was recorded in 1st March pruned trees and minimum (9.10%) was observed in 15 April pruned trees and they differed statistically. The treatments D_2,D_3,D_4 and D_5 were on par with each other.

4.5.1.9 Pulp to stone ratio

The data pertaining to pulp to stone ratio was arrived by deviding the pulp weight with stone weight, and were presented in Table-14. Maximum pulp to stone ratio (9.96) was observed in D_4 (15 April) which was followed by D_5 (30 April)

Table - 14 : Effect of time of pruning on physical parameters of ber fruits

Sl. No.	Volume (cc)	Length (cm)	Diameter (cm)	Fruit weight (gm)	Pulp weight (gm)	Stone weight (gm)	Pulp (%)	Stone (%)	Pulp to stone ratio
D_1	15.67	2.93	2.80	10.28	9.08	1.20	88.32	11.68	7.56
D_2	16.90	2.96	2.84	10.77	9.59	1.18	89.02	10.98	8.12
D_3	22.40	3.35	3.23	14.40	13.08	1.32	90.82	9.18	9.90
D_4	19.07	3.26	3.13	13.70	12.45	1.25	90.90	9.10	9.96
D_5	20.85	3.29	3.14	13.91	12.64	1.27	90.84	9.16	9.95
S.E.	0.58	0.02	0.029	0.29	0.34	0.11	0.98	0.98	0.90
C.D (0.05)	1.26	0.06	0.063	0.65	0.74	0.23	2.15	2.15	1.96

Table - 15 : Effect of time of pruning on chemical parameters of ber fruits

Sl. No.	T.S.S. (%)	Acidity (%)	Brixto acid ratio	Ascorbic acid (mg/100g)	Total Sugars (%)	Reducing Sugar (%)
D_1	11.35	0.416	27.28	88.30	8.92	3.76
D_2	11.55	0.408	28.31	93.62	9.05	3.77
D_3	14.50	0.384	37.76	103.05	9.17	4.23
D_4	13.60	0.390	34.84	108.40	9.21	4.11
D_5	12.55	0.414	30.28	99.35	9.09	3.93
S.E.	0.35	0.0069	1.09	3.47	0.20	0.07
C.D (0.05)	0.76	0.015	2.38	7.56	0.43	0.16

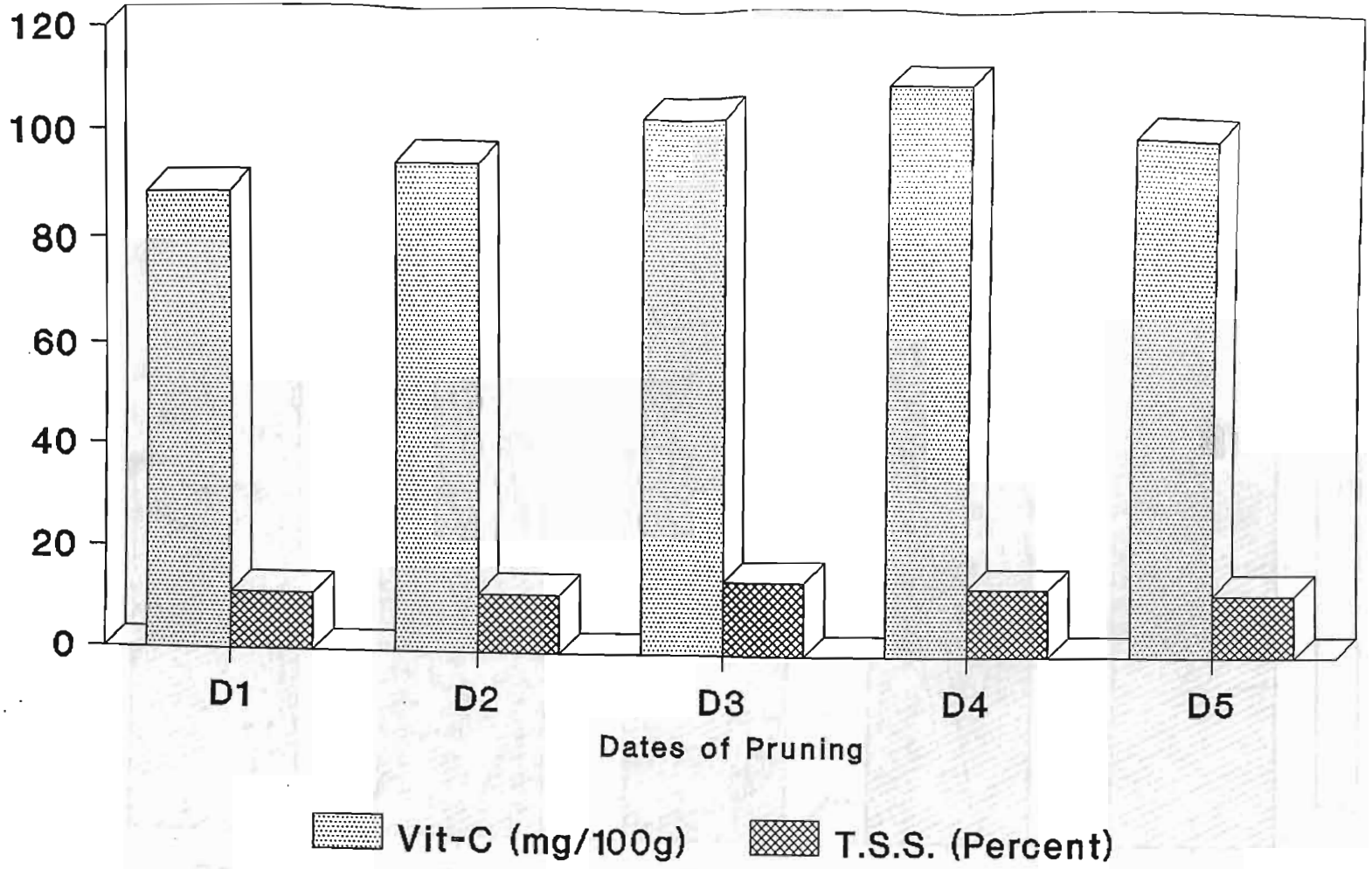

Fig.4 Effect of time of pruning on the vit-C (mg per 100 gms of pulp) and T.S.S.(%) of ber fruits.

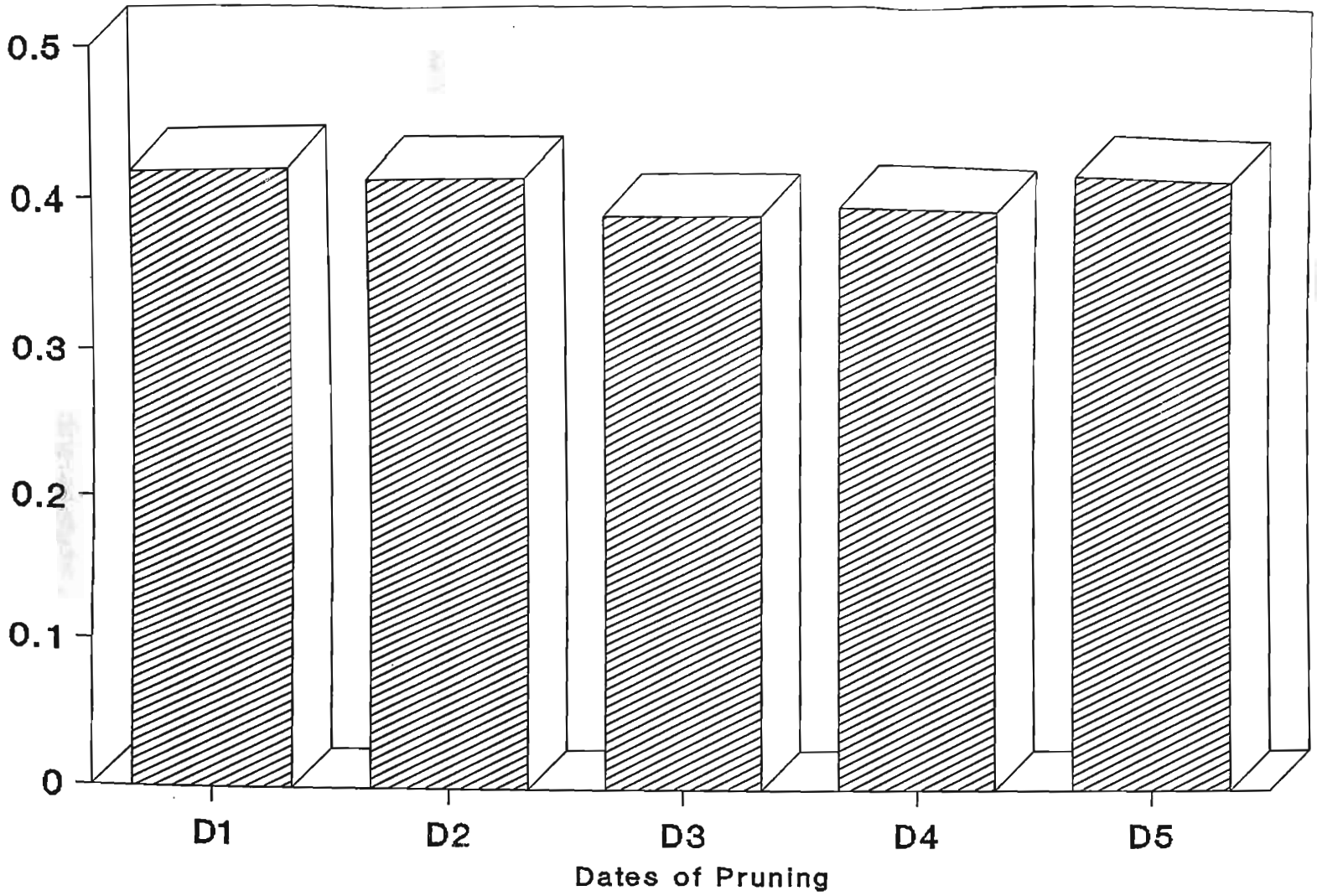

Fig. 5 Effect of time of pruning on the acidity (%) content of ber fruits

(9.95) and D_3 (31 March) (9.90) which did not differ statistically but differed significantly from D_1 and D_2 treatments, which recorded pulp to stone ratio of 7.56 and 8.12 respectively.

4.5.2 Chemical Characters

4.5.2.1 Total soluble solids (T.S.S %)

The data presented in table-15 and Fig.4. reveal that there is significant influence of pruning time on the T.S.S of the fruits. Treatment D_3 recorded maximum (14.50) percentage of T.S.S and it is followed by D_4 (13.60) and D_5 (12.55) and they differ statistically among themselves. Minimum (11.35) percentage of T.S.S was observed in D_1. The treatments D_2(11.55) and D_1 (11.35) were onpar.

4.5.2.2 Titrable acidity (%)

The data furnished in Table - 15 and Fig. 5 show significant response of ber trees to different pruning dates, with respect to titrable acidity. Highest titrable acidity was recorded by the D_1 (0.416) and least was recorded in D_3 (0.384) which differ statistically. The treatments D_1,D_5 and D_2 and D_3 and D_4 were of same order.

4.5.2.3 Brix to acid ratio

From the Table-15 it is clear that there is significant difference between the treatments. Highest Brix to acid ratio (37.76) was obtained in D_3 and least (27.28) was obtained with D_1 and they differed statistically. The treatments D_1 and D_2 were on par with each other.

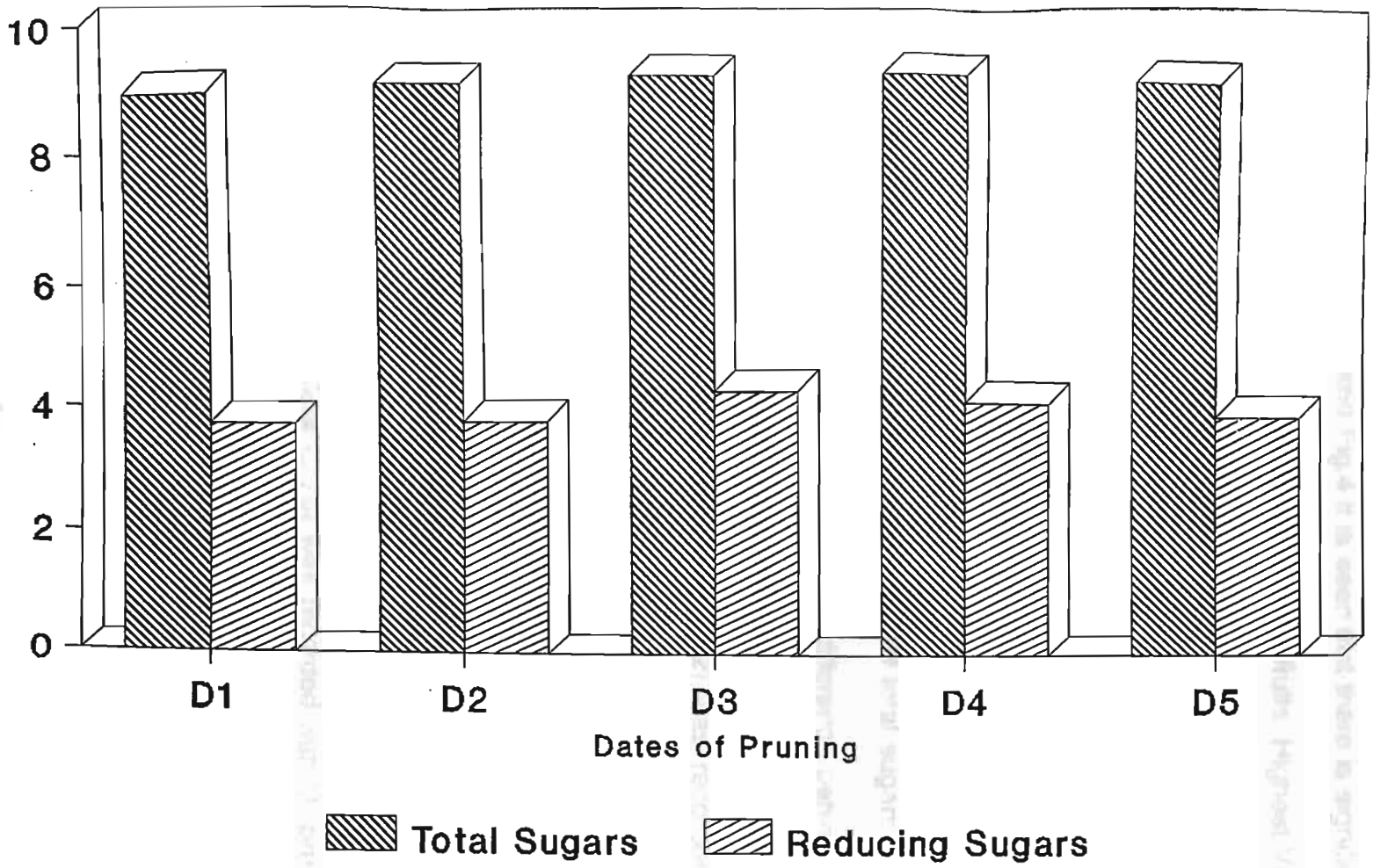

Fig.6 Effect of time of pruning on total and reducing sugars (%) of ber fruits

4.5.2.4 Ascorbic acid (Vitamin-C) content (mg/100g. of pulp)

From the Table-15 and Fig.4 it is seen that there is significant influence of different pruning periods on ascorbic acid of the fruits. Highest Vitamin-C content was recorded in D_4 (108.40mg/100g. of pulp) and least was recorded in D_1 (88.30mg/100g. of pulp) and they differed statistically. The treatments D_3 and D_4 were onpar.

4.5.2.5 Total sugars (%)

Observations regarding the percentage of total sugars were presented in Table-15 and Fig.6. There was no significant difference between the treatments in respect of percentage of total sugars. Highest value was recorded by D_4 (9.21) and is followed by D_3 (9.17). Least value (8.92) was recorded by D_1. All the treatments were of same order.

4.5.2.6 Reducing sugars (%)

There was significant influence of different pruning treatments on percentage of reducing sugars (Table-15 and Fig.6). Highest percentage (4.23) was recorded with D_3 and least (3.76) was recorded with D_1 pruning dates. The treatments D_3 and D_4 and D_1 and D_2 were onpar with each other.

Table - 16 : Effect of time of pruning on percentage of infestation of fruitfly

Sl.No.	% infestation
D_1	57.75 (49.43)
D_2	53.25 (46.83)
D_3	37.75 (37.88)
D_4	42.25 (40.51)
D_5	45.50 (42.42)
S.E.	2.54
C.D (0.05)	5.54

* Values in parantheses are angular transformed values.

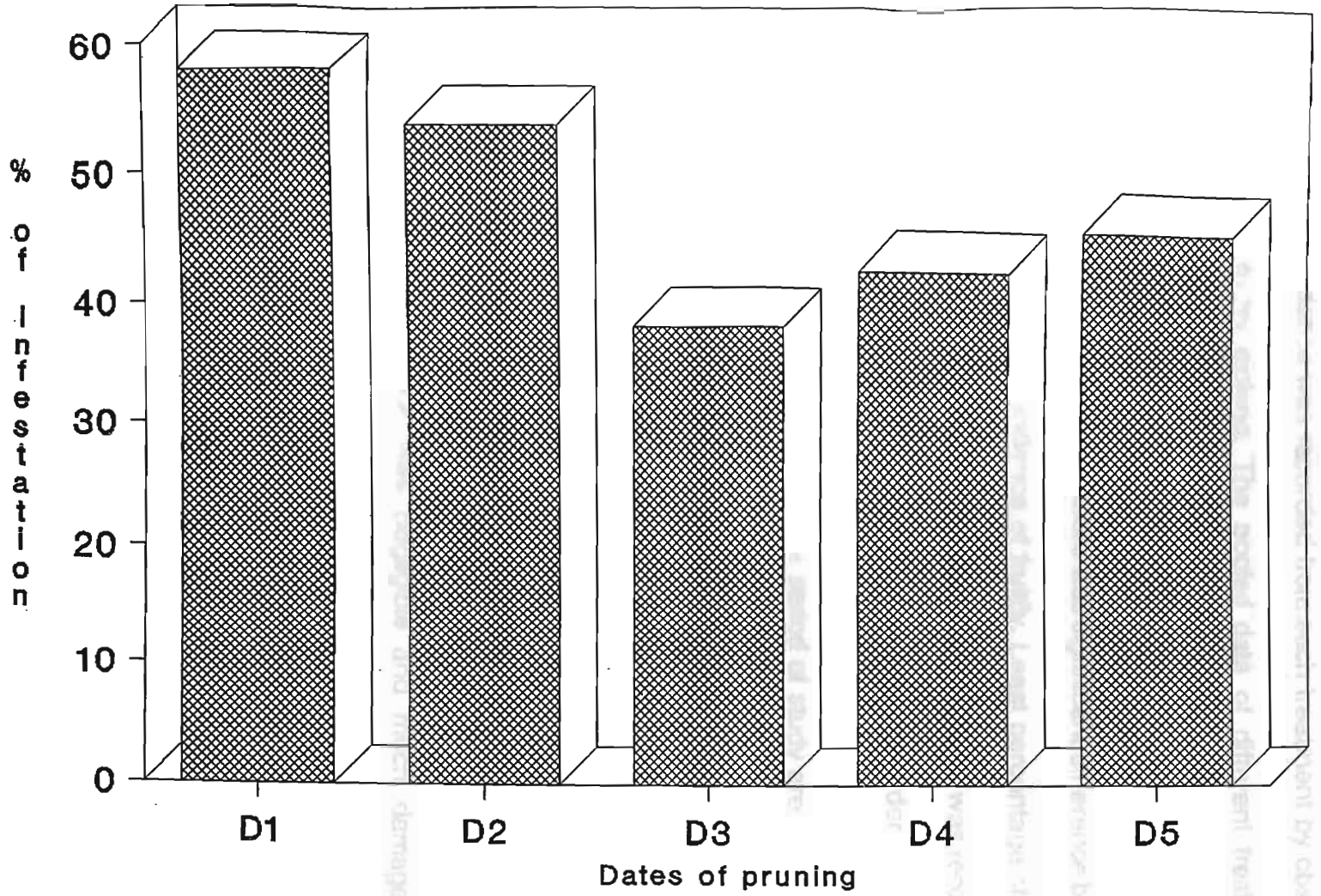

Fig. 7 Effect time of pruning on percentage of infestation of fruitfly

4.6 INCIDENCE OF PESTS

The fruitfly incidence was recorded from each treatment by observing 100 fruits randomly at every picking. The pooled data of different treatments are presented in Table-16 and Fig-7.

The observations revealed that there was significant difference between the pruning periods in respect of incidence of fruitfly. Least percentage of infestation (37.75%) was recorded in D_3 and highest infestation (49.73%) was recorded in D_1. The treatments D_3,D_4 and D_5 and D_1 and D_2 were of same order.

The other pests observed during the period of study are:

1. Hairy caterpillar - *Euproctis fraterna.*
2. Cowbugs - *Oxyrachis terandus.*
3. Beetles - *Cosdylocera sps.*
4. Red cotton bugs - *Dysdercus cingulatus.*

However, their incidence was negligible and much damage was not observed.

Discussion

CHAPTER - V

DISCUSSION

Pruning of ber trees (*Zizyphus mauritiana Lamk*) is indispensible in order to get high yield and better quality product, because ber bears fruit on current season's growth. Unpruned trees produced little new growth and straggling twigs making the tree dense without chance for the light penetration resulting in poor yields. Further, dense growth of unpruned trees increase the incidence of pests and diseases. Thus pruning is essential for inducing fruitfulness and minimise the incidence of pests and diseases in ber. Having thus realized the importance of pruning in ber, next it becomes necessary to specify an ideal time of pruning trees. This is because the pruning time and ensuing season after pruning influence the performance of the pruned trees. This has been demonstrated well in grape, phalsa, peaches, apples etc. Staggering of pruning also extends the season of availability of ber in the market and is also helpful in avoiding the incidence of pests and diseases.

However, the time of pruning depends upon the area, where ber is raised. Ber is cultivated throughout the country under different set of climatic conditions. Much literature is available on the time of pruning and its effect on growth, flowering, fruiting and fruit quality of ber, particularly under North Indian conditions. Oflate ber cultivation is extending in dry tracts of South India. Recommendations on ber pruning generally suggest dormant pruning in May-June in North-India. The ber trees in North India enter into dormancy after completion of fruiting by the end of April and will be in deep dormancy by the end of May (Zora singh and Sandhu,

1984b). On the other hand, harvesting in ber under South Indian conditions will be over by December - January, but the trees will not enter into dormancy immediately, though the temperatures fall. This may be due to the fact that the prevailing temperatures during December - February, may not be sufficient to induce dormancy. With the rise in temperature in March defoliation starts slowly and by mid-May the trees will be almost bare and in dormancy. This variation in the commencement of dormancy in ber trees is mainly due to varying climatic conditions under which ber is raised. The climate of North India is subtropical with distinct seasons and temperature in certain tracts touching almost zero level, while that of South India is tropical and equitable and temperature rarely go below 10°C. This suggests to change the pruning time. The general recommendation of May pruning of Northern India may not hold good as suitable time of ber pruning for South India also. Thus it is essential to find out the best time of pruning of this summer dormant fruit crop for South India.

Thus keeping the above in view, a trial was conducted on about 10 year old ber trees of Gola growing on a sandy clay at 6X6m spacing. The objective of the study is to determine a suitable time for pruning of ber trees in Southern region of Andhra Pradesh. The ber trees were pruned at fortnightly intervals from 1st March to 30th April.

The effects of time of pruning, on vegetative growth, flowering, fruiting, fruit quality and incidence of pests at Tirupati (located in the southern region of Andhra Pradesh) presented in the previous chapter are discussed in this chapter in the light of the available literature on ber and other fruit crops.

EFFECT OF TIME OF PRUNING ON GROWTH

The effect of pruning ber at different dates on tree height, trunk girth and tree spread was not significant. Zora singh and sandhu (1984a) in ber; Singh and Sharma (1961) and Naram Naidu (1987) in phalsa also did not find significant influence of time of pruning on the height of the plant. This was attributed to differential growth rate of the plants tried. On the other hand, Ramadevi (1989) observed significant effect of pruning at different dates on the height of ber trees growing on clay loam at Hyderabad. This variation may be ascribed to the variation in the age of the trees in the present study and also varying soil and climatic conditions available at Tirupati as compared to Hyderabad. It is also observed in the present studies that the trunk girth was not effected significantly by staggering of pruning. These observations are in line with those of Gupta and Godara (1987) in ber. Tree spread was also not influenced by different dates of pruning. Zora Singh and Sandhu (1984a) at Ludhiana and Ramadevi (1989) at Hyderabad in ber, and Singh and Sharma (1961) and Naram Naidu (1987) in phalsa also reported non-significant effect of pruning dates on tree spread.

Vegetative growth parameters recorded lower values in the early pruned trees as compared with delayed pruned trees (Table-2). However, pruning of ber (Variety-Gola) on different dates at Hyderabad gave higher values in the early pruned trees as compared with the late pruned trees (Ramadevi, 1989). This may be due to the differences in the weather conditions prevailing at Hyderabad and Tirupati and also the soil on which they are growing. The climate of Hyderabad falls in the belt of semi-arid tropical climate, while Tirupati falls in tropical climate belt.

Further, high temperatures prevailing in the ensuing months might have slowed the growth of the plants resulting in non-significant influence of dates of pruning on plant height, trunk girth. Naram Naidu (1987) contended that the failure of phalsa bushes to respond to pruning in December was due to checking of vegetative growth by low temperature, unlike in the present study.

Pruning removes the apical dominance and thus releases the other buds from inhibition. The time taken for release of inhibition of buds depends upon the time of pruning coupled with climatic conditions prevailing during the ensuing period of pruning. In the present studies, early pruned trees sprouted early and the sprouting was delayed as the pruning was delayed (Table-5). The time taken for bud sprouting, regardless of the dates of pruning, ranged from 17 days (D_1) to 22 days (D_4 and D_5). The delayed sprouting in late pruned trees may be due to the higher temperatures prevailing during May-June, which might have checked the sprouting and prolonged the inactivity (dormancy), as by nature ber is summer deciduous species. Singh (1973), Zora Singh and Sandhu (1984a and 1984b), Pareek (1987), Ramadevi (1989) and Kundu *et al.* (1994) in ber and Singh and Sharma (1961) and Naram Naidu (1987) in phalsa also observed similar effects of time of pruning.

The main objective of pruning ber tree is to induce more number of new shoots, since the production occurs on these new shoots only. Pruning invigorates the dormant buds by eliminating the apical dominance. However, time of pruning had little influence on the production of new shoots. In the present study, the number of new shoots was highest with delayed pruning, but the effect was not significant. The new shoots inturn produce secondary and tertiary twigs (laterals) which also bear fruits. So their production is also desirable. The number of such

laterals per new shoot was least in late pruned trees. This might be ascribed to the greater number of shoots produced by these late pruned trees. The production of new shoots exhausts the food and energies, hence the production of laterals depend upon the production of new shoots. It is evident from many studies that pruning changes total dry weight partitioning in such a way that more dry weight is added to new shoots than to remaining parts. The high production of new shoots thus checked the production of laterals in late pruned trees. Thus,it is clear that greater the numbers of shoots, less will be the laterals produced on the newshoots. Similar findings were documented by Zora Singh and Sandhu (1984a) and Ramadevi (1989) in ber, who reported that the time of pruning had no influence on the production of laterals on new shoots.

Time of pruning has influenced the length of newshoots significantly, but the trend was erratic. At any date of observation of the length of new shoots was higher than that of others, but significantly equal to that of late pruned (D_5) trees. Shortest shoots resulted in the second date of pruning (D_2). Plant spread generally depends on the length of the shoots. However, this didnot corroborate in the present studies. Though the length of new shoots was highest with early pruned trees (D_1), the number of shoots per tree under this treatment was least, which might be the reason for increased length of shoots. However, this did not reflect in other treatments. Trees pruned at the end (D_5) produced more number of shoots as well as longer shoots. Longer shoots due to early pruning in ber were also observed by Ramadevi (1989), Sandhu *et al.* (1992) but Kundu *et al.* (1994) reported longer shoots due to delayed pruning upto 30 May, but with further delay (15 June) it decreased. This difference my be due to the variation in the genetic make up of the varieties of ber studied and also place of cultivation of ber and degree of dormancy at the time of pruning.

EFFECT OF TIME PRUNING ON FLOWERING

One of the aims of pruning is to regulate time of flowering and it is achieved in the present investigation. Early pruned ber trees came to flowering early and as the pruning was delayed there was corresponding delay in flowering. The usual time of flowering in ber in South India is July-August. The data (Table 16) indicated that the flowering advanced due to early pruning. The time taken for pruned trees to come to flowering, varied with different dates, but erratically. Trees pruned on first March took least period (60 days) for flowering, followed by those pruned on 15th March (65 days). On the other hand, trees pruned on 30th April, took longer period (71 days) for blooming. A perusal of the data (Table 5) indicates that sprouting of vegetative buds was earlier in early pruned trees as compared with those pruned late. This might have also reflected in the time taken for flowering after pruning. Similar positive co-relation of sprouting and flowering with the time of pruning ber had been reported earlier (Zora Singh and Sandhu, 1984a; Pareek, 1987; Ramadevi, 1989; Gupta *et al.*, 1990 and Kundu *et al.*, 1994) at different locations, Zora Singh and Sandhu (1984a) obtained an advancement of 14 days by early pruning ber under subtropical climate of Ludhiana. However, irrespective of time of pruning all the pruned trees have come to flowering in the month of September it self from 9th to 19th (a duration of 10 days), unlike in the present study, wherein the commencement of flowering in different treatments has spread over four months (April, May,June and July). Ramadevi (1989) under semi-arid tropical conditions of Hyderabad observed the initiation of flowering over four months i.e. May, June, July and August. This variation may be due to dates of pruning adopted differently at Hyderabad and Tirupati. In a confirmation study of effect of time of pruning on flowering in Umran ber at Ludhiana, Sandhu *et al.* (1992) obtained flowering advanced by 24 days in earliest pruned trees.

In general, the time taken for flower intiation after pruning in ber was shorter (60-71days) under South Indian conditions, than that reported from North India, where more number of days (63 - 147 days) were required for initiation of flowering (Zora Singh and Sandhu, 1984a; Sandhu *et al.*, 1992). In the present investigation as the pruning was delayed progressively more number of days were required for initiation of flowering unlike at Ludhiana, where a reverse effect was reported (Sandhu *et al.*, 1992). This may be that pruning at Ludhiana was delayed as compared to the dates in the present study and also done when the dormancy in the trees is approaching termination. Similarly, pruning, trees when they are terminating their dormancy might have reduced the time taken for coming to flowering as the usual flowering time under South conditions in general is July-August (Sampath Kumar, 1983). This variation may be due to the difference in the prevailing climatic conditions of the places of investigation. Further, Zora Singh and Sandhu (1984a) have pruned the trees immediately after harvesting fruits, even before the trees started defoliation, during dormancy and after dormancy. In the present trial plants were pruned, about three month after fruiting and before the trees entered into complete dormancy. Thus the variation in the results may be explained.

Flowers in ber are borne in axillary cymes with varying numbers. The production of flower clusters (cymes) depends on the vigour of the plant and season. From Basti (Uttar Pradesh) Teaotia and Chauhan (1963) reported that the number of flowers in a cyme will be around 16. Time of pruning was significant on the production of cymes (Table 10). The number of cymes per shoot increased progressively upto 75 days and at final observation (90 DAF) showed sudden decline. This decline may be due to non-inclusion of earlier borne cymes as they

have set fruit. Similar trend was also reported by Ramadevi (1989). The number of cymes was significantly maximum in trees pruned on 1st March at any date of observation except at 60 DAF. However, a perusal of the data in Table 10 shows an erratic response of ber trees to time of pruning in the production of flower clusters.

The production of flowers in a cyme also responded significantly to different dates of pruning and showed a similar trend as that of number of cymes per shoot. Trees pruned on 31st March recorded maximum number of flowers per cyme. In general, number of flowers per cyme was less in trees pruned early, however the effect of time of pruning on the number of flowers per cyme was not consistent. This observation is in accordance with the study of Ramadevi (1989). However, Zora Singh and Sandhu (1984a) have reported that early pruned trees initiated more number of flowers per cyme than late pruned ones, in umran ber under Ludhiana conditions. This variation may be due to variation in the variety selected as well as variation in the climatic conditions and dates of pruning.

EFFECT OF PRUNING ON FRUITING

Trees pruned early have come to first picking early and those pruned late came late to first picking. The trend is similar to commencement of flowering. As the pruning was delayed, the gap between first pruned trees and next pruned trees increased progressively. However, the trees pruned on 16th March (D_2) and 31st March (D_3) with 15 days gap have come to first picking simultaneously with one day gap. Trees pruned on different dates have come to first picking simultaneously at Hyderabad (Ramadevi, 1989), while the commencement of flowering has spread

over three months, the commencement of picking has spead over two months (November and December). In the present investigation also similar observation was made. Thus, it is possible to advance the date of harvesting as well as extend the harvesting season by staggered pruning. Zora Singh and Sandhu (1984a) reported that irrespective of dates of pruning all the pruned trees have come to first picking during a single month (March) only, indicating that time of pruning has no effect on the date of picking, hence time of pruning is not important under North Indian conditions. It appears even under South Indian condition also, time of pruning is not much important since all the trees pruned at different dates have come to picking during November and December over a period of 22 days. This is in line with the results of Ramadevi (1989) at Hyderabad.

When the duration (days) or time taken for the trees to come to first picking after pruning was considered for evaluation, it was noted that early pruned trees took longer duration of 258 days and the duration declined progressively as the pruning was delayed. First pruned trees took more time to come to first picking than the trees of subsequent pruning. This may be due to the fact that the fruits of early pruned trees passed their growth and development at relatively higher temperatures than those of subsequently pruned trees. Higher temperatures and rains might have slowed the rate of growth and development. Similar trend was reported by Zora Singh (1984a) from Ludhiana and Ramadevi (1989) from Hyderabad. However, under Ludhiana conditions, pruned trees took longer duration (257 to 325 days) to first picking after pruning, while under Hyderabad conditions, the duration was less (217 to 248 days). This way be attributed to the period of maturity varying at these places. Ber fruits in North India, mature during severe winter and early spring, when the prevailing low temperatures might be

inhibiting the growth and development of fruits. On the other hand, ber fruits mature in South India during post mansoon and early winter, when the temperatures are high enough to allow the normal growth and development. Between Hyderabad and Tirupati, the time taken for pruned trees to reach the picking stage is longer at Tirupati than at Hyderabad. This is due to continuity of rains during October and November, when the fruits are growing and developing, which have retarded the rate of maturation.

EFFECT OF TIME OF PRUNING ON YIELD

The results of several pruning studies on different crops show that pruning has a great influence on yield and regularity of bearing. However, the results depend on species, variety, tree age, growing conditions, time and severity of pruning.

In the present investigation highly significant influence on the yield of fruits was noted. Mid pruning gave highest yield of 60.25 kg. per tree, followed by fourth date of pruning (41.32kg.). Second date of pruning resulted in lowest yield (17.02kg.).

Significant influence of time of pruning on tree yields of ber was obtained earlier at different places (Zora Singh and Sandhu, 1984b; Ramadevi, 1989; Sandhu *et al.,* 1992; Patil *et al.,* 1996). Zora Singh and Sandhu (1984b) observed that delayed prunings in June and July resulted in low yields as compared to April and May prunings under subtropical climate of Ludhiana, and attributed this response of ber trees to higher amount of reserve metabolites such as carbohydrates, starch and sugars during deep dormancy (May) than during

induction phase and breaking phase of dormancy during June and July. Ramadevi (1989) also expressed the same opinion from Hyderabad. Pruning the ber trees during deep dormancy leads to more growth, higher fruit set and greater yields (Sandhu *et al.,* 1992). Patil *et al.* (1996) are of the opinion that highest fruit yield in the March pruned trees might be due to higher fruit set and more number of flowers per cyme under Dharwad conditions.

In the present investigation also higher number of cymes, higher number of flowers per cyme and increased fruit set (not shown here) might have contributed to highest yield in respect of trees pruned on 31st March, as compared to other dates which have produced markedly reduced number of cymes, flowers per cyme and moderate fruit set.

EFFECT OF TIME OF PRUNING ON FRUIT QUALITY

A perusal of the data on physico-chemical parameters of ber fruits reveals the significant influence of time of pruning on these parameters. Significant influence of time of pruning on physico-chemical characters of ber fruits was earlier reported (Zora Singh and Sandhu 1984; Gupta and Godara, 1987; Ramadevi 1989; Gupta *et al.,* 1990; Sandhu *et al.,* 1992; Kundu *et al.,* 1995; Patil *et al.,* 1996; Jawadagi *et al.,* 1996) from different places with different cultivars.

Significant differences among the dates of pruning were noted inrespect of volume, length and diameter of the fruits, fruit weight, pulp weight, percentage of pulp and seed, whereas there were no differences in respect of stone weight and pulp to stone ratio (Table 15). The fruits from trees pruned on 31 March had maximum volume (22.4cc), maximum length (3.35 cm) and diameter (3.23 cm),

fruit weight (14.48) and maximum pulp weight (13.08g). Mid pruning had proved more effective than early and late pruning. Ramadevi (1989), Kundu *et al.* (1995), Jawadagi *et al.* (1996) also reported that mid-pruning gave high values for physical parameters. On the other hand, delayed pruning given in July significantly reduced the size and weight of fruits of Umran ber at Ludhiana (Sandhu *et al.*, 1992), which was attributed to the delayed and reduced growth and less time from flowering to fruit maturity in late pruned trees, which affected the development of fruit thus reducing the size and weight of fruit in late pruned trees. Sandhu and Singh (1984) had also reported that late pruning resulted in reduced fruit size and fruit weight. Whereas, Patil *et al.* (1996) from Dharwad observed mid pruning - first fortnight of March, giving less fruit weight as compared with early and late prunings, which was due to higher number of fruits per tree.

The chemical composition of ber fruits from pruned trees was also effected by different dates of pruning, but the trends were found to be erratic, in the sense, a clear trend is not observed with different parameters (Table 16). Maximum TSS (14.50%), highest brix acid ratio (37.76) and maximum content of reducing sugars (4.23) were noted in fruits from trees pruned on 31st March (D_3). Acidity was highest (0.416%) in fruits from trees pruned on first date (D_1). Ascorbic acid (108.40 mg) and Total sugars (9.21%) were highest in fruits from trees pruned on 15th April (D_4). Thus, a particular trend was not observed. Similar erratic trend of influence of dates of pruning on chemical composition of fruits was observed at Hyderabad (Ramadevi, 1989) and at Ludhiana (Zora Singh and Sandhu, 1984b). In case of ascorbic acid , contrary to the erratic trend due to different dates of pruning in the present study, a definite trend of linear increase in the content with pruning date extension, has been reported from Hyderabad (Ramadevi, 1989) and decreasing trend from Dharwad (Patil *et al.*, 1996) and from Hissar (Kundu *et al.*, 1995).

This differential influence of dates of pruning on chemical composition may be due to the different varieties included in the studies and also due to varying agro-climatic conditions prevailing at the places of experimentation.

EFFECT OF TIME OF PRUNING ON THE INCIDENCE OF FRUIT FLY.

One of the objective of present investigation is to observe the influence of dates of pruning on the incidence of fruit fly, the major pest of ber. The aim was to find out whether it is possible to avoid the pest incidence by adjusting the time of pruning ber trees.

Significant influence of time of pruning on the pest damage was observed (Table 17). The damage due to fruit fly was significantly highest (57.75%)in fruits from trees pruned on 1st March (D_1) closely followed by those pruned on 16th March (D_2). The damage was least with mid-pruning (D_3). The damage rised from 42.25 percent with D_4 to 45.50 percent with D_5 pruning treatments. This indicates that it is possible to minimise the incidence of fruit fly by adjusting the time of pruning, so that the critical stage of fruit for oviposition of fruit fly does not coincide. The low damage of fruits due to fruit fly in the fruit from mid-pruning treatments may be that the critical stage of fruit for oviposition of fruitfly might have occurred in the thick of rainy season, when climatical conditions may not be favourable for the pest as the fly becomes active in Autumn and activity continues through out winter and spring (Bhutani, 1979).

CONCLUSION

From the forgoing discussion of results of the investigation, it is clear that the time of pruning has significantly influenced various parameters of growth, flowering, fruiting, yield and quality of ber fruits under the prevailing agro-climatic conditions of Tirupati. It is also noted that the responses of ber trees to different dates of pruning is not consistent, but erratic in several cases. However, it was possible to advance flowering date and there by harvesting season also considerably. Yields could also be regulated by time of pruning. Physico-chemical parameters of ber fruits were also significantly and considerably influenced by different dates of pruning.

From the results obtained, it may tentatively be concluded that under the prevailing agro-climatic conditions of Tirupati, ber tree of Gola cultivar may be pruned during last week of March to achieve good yields and better quality fruits and to avoid the incidence of fruit fly.

Summary

CHAPTER - VI

SUMMARY

An experiment on the effect of time of pruning on ten year old ber trees of Gola growing on a sandy clay soil at 6 X 6m spacing was conducted at S.V.Agricultural College, Tirupati during March 1998 to December 1998. The trees were pruned at 5 different dates at fortnightly intervals viz. 1st March, 16th March, 31st March, 15th April, 30th April, which served as treatments and were replicated four times in the design RBD.

- Tree characters were not influenced significantly by the different dates of pruning.
- Vegetative bud sprouting was earlier in early pruned trees and it was delayed as the pruning was delayed.
- Delayed pruning produced longer new shoots.
- Delayed pruning resulted in the production of greater number of new shoots per tree.
- The production of laterals on new shoots was highest with early pruning and least with delayed pruning.
- Early pruning resulted in early flowering with minimum number of days (60) required to come to flowering.
- Trees pruned early have come to first picking early as compared to trees pruned late.

- Highest yields were obtained from the trees pruned on 31st March and minimum yields from 16th March pruned trees.

- Fruits harvested from 31st March pruned trees were found to be superior to other in physical parameters.

- The fruits harvested from the trees pruned on 31st March recorded higher values of quality parameters such as T.S.S (%), Brix to acid ratio, reducing sugar(%) etc.

- Acidity was higher in fruits of 1st March and Ascorbic acid was higher in 15th April pruned trees.

- The 31st March pruned trees recorded least percentage of infestation of fruit fly compared to other dates of pruning.

- From the results obtained it may tentatively be concluded that under the prevailing agro-climatic conditions of Tirupati, ber trees of Gola cultivar may be pruned during last week of March to achieve good yields and better quality fruits.

Literature Cited

LITERATURE CITED

A.O.A.C. Methods 1980. 13th edition, Washington D.C.

Awasthi A N and Misra R S 1969 Effect of pruning on the subsequent vegetative growth, fruit set, fruit drop and quality of ber (*Zizyphus mauritiana Lamk*). Punjab Horticultural Journal 9 : 54-60.

Bajwa M S and Sarowa P S 1977 Training and pruning in ber. Punjab Horticultural Journal 17 : 52-53.

Bharad S G and Tayde G S 1997 Studies on severity and time of pruning on growth, flowering, fruit set, yield and quality in ber varieties. Thesis abstracts-Directorate of publications chaudhary Charan Singh Haryana Agricultural University No.4 Vol.XXIII.

Bhat V R and Hulamani N C 1994 Studies on back pruning in *Vinifera* grape cultivars. karnataka Journal of Agricultural Sciences 7(4) : 400-405.

Butani D K 1979 Insects and fruits. Published by Khosla and Pragati printers, Delhi, pp.173-186.

*Deoju L N 1983 Bud burst in grapevine cv. Thompson seedless (*vitis vinifera L.*) as influenced by time of pruning and certain chemicals. M.Sc. thesis submitted to University of Agricultural Sciences, Bangalore.

Gupta R B and Godara N R 1989 Effect of time and Severity of pruning on growth, quality and yield in ber (*Zizyphus mauritiana* Lamk) cv. Umran. Progressive Horticulture 21(1-2) : 15-20.

Gupta R B, Godara N R and Chauman K S 1990 Effect of time and severity of pruning on flowering and fruiting of ber (*Zizyphus mauritiana* Lamk) cv. Umran. Haryana Journal of Horticultural Sciences 19(1-2) : 45-49.

Hayes W B 1957 Fruit growing in India. Published by Kitabistan Allahabad - 1. pp.412.

Janardhana Rao L and Rama Krishna Reddy M G 1989 Effect of time and severity of pruning on yield of phalsa (*Grewia asiatica* L.). South Indian Horticulture 37(2) : 115-117.

Jawadagi R S, Rao M M, Hire math Alur A S and Patil B C 1996 Effect of time and severity of pruning on growth, flower, fruit set, fruit retention, yield and quality parameters in umran ber (*Zizyphus mauritiana* Lamk). Farming systems 13 (3-4) : 42-46.

Kundu S S, Pareek O P and Gupta A K 1994 Effect of time and severity of pruning on growth, flowering and fruiting in ber (*Zizyphus mauritiana* Lamk) cv. Umran. Annals of Arid-Zone 33(1) : 49-52.

Kundu S S, Pareek O P and Gupta A K 1995 Effect of time and severity of pruning on physico-chemical characteristics and yield of ber (*Zizyphus mauritiana* Lamk) cv. Umran. Haryana Journal of Horticultural Science 24(1) : 23-30.

Lal H and Prasad A 1980 Effect of Pruning on flowering, fruit set and fruit retention. Punjab Horticultural Journal 20 : 52-55.

Nanthakumar S and Shanmugavelu K G 1991 Studies on the effect of pruning on number of leaf and leaf area of certain ber cultivars (*Zizyphus mauritiana* Lamk) and (*Zizyphus rotundifolia* Lamk). Indian Horticulture 39(4) : 229-231.

Naram Naidu L 1987 studies on the effect of time and severity of pruning on phalsa (*Grewia asiatica L.*). M.Sc (Ag) thesis submitted to Andhra Pradesh Agricultural University, Hyderabad.

*Onokipse O U and Inyang I D 1987 Early pruning of Muscadine and Bunch grape cultivars in North Florida. Proceeding-of-the Florida-State-Horticultural-Society 100 : 310 - 312.

Panse V G and Sukhatme 1967 Statistical methods, for Agricultural workers. Indian Council of Agricultural Research, New Delhi 2nd ed. 381.

*Pareek O P 1986 standardization of pruning time in ber Bawal, Hissar, Rahuri). Annual report All India co-ordinated Research project on Arid zone Fruits. Indian council of Agricultural Research. Tech Doc No.22, pp.92-94.

*Pareek op 1987 standardization of pruning time in ber (Aruppukottai, Bawal, Hissar, Rachuri). Annual report All India co-ordinated Research project on Arid Zone Fruits. Indian council of Agricultural Research. Tech Doc No.25, pp.92-97.

Parthasarathy Reddy V and Satyanarayana G 1970 Effect of time of pruning on growth, flowering, yield and quality of Anab-e-shahi grape (*vitis vinifera* L.) Andhra Agricultural Journal 17 : 112-115.

Patil S S and Hulamani N C 1994 Studies on pruning time in Ber (*Zizyphus mauritiana* Lamk) cultivars under Transitional zone. M.Sc (Ag) thesis submitted to University of Agricultural Sciences, Dharwad.

Patil S S, Patil S L, Basava Rajeshwari Patil, Katti V S and Hulamani N C 1996 Effect of pruning period on yield and quality of different ber (*Zizyphus mauritiana* Lamk) cultivars under Dharwad conditions. Farming systems 13 (3-4) : 37 - 41.

Patil V K 1975 studies on the time of pruning of Anab-e-shahi cultivar of grape (*vitis vinifera* L.) under Akola conditions. Punjab Horticultural Journal 15 : 92-94.

Ramadevi I 1989 Studies on the effect of time of pruning on ber (*Zizyphus mauritiana* Lamk) under Hyderabad (Andhra Pradesh) conditions. M.Sc (Ag.) thesis submitted to Acharya N.G.Ranga Agricultural University, Hyderabad.

Ranganna S 1977 Manual of Analysis of Fruit and Vegetable Products. Tata Mc Graw - Hill Publishers, New Delhi, India pp.7-95.

Sampath Kumar P 1983 Studies on the performance of ber (*Zizyphus mauritiana* Lamk) under Hyderabad conditions. M.Sc (Ag.) thesis submitted to Andhra Pradesh Agricultural University, Hyderabad, Andhra Pradesh.

Sandhu A S, Minhas P P S and Grewal G P S 1992 Influence of time of pruning on growth, flowering, fruiting and fruit quality of umran ber (*Zizyphus mauritiana* Lamk). Haryana Journal of Horticultural Sciences 21 (1-2): 1-5.

Sandhu A S and Singh Z 1984 Effect of pruning time on productivity and physico-chemical characters of ber cv Umran. Journal of Research Punjab Agricultural University 21(4) : 521-524.

Shinde N N and Rane D A 1979 Influence of Pruning severity and time of pruning on growth, production and quality of Bangalore Purple grapes. Progressive Horticulture 11 : 5-12.

Shinde N N, Santakke M B and warke D C 1976 Effect of severity of pruning at different periods on growth and yield of phalsa (*Grewia asiatica* L.) under Parbhani (Maharastra) conditions. Journal of Maharastra Agricultural University 1: 157-158.

Singh J P 1974 The phalsa. Indian Horticulture 19 : 15-16.

Singh J P and Sharma H C 1961 Effect of time and severity of pruning on growth, yield and fruit quality of phalsa (*Grewia asiatica* L.). Indian Journal of Horticulture 18 : 20-28.

Teaotia S S and chauhan R S 1963 Flowering, pollination, fruit set and fruit drop studies in ber (*Zizyphus mauritiana* Lamk). I floral biology. Punjab horticultural Journal 3 : 60-70.

Vashistha B B and pareek O P 1978 Flower morphology, fruit set and fruit drop in some ber (*Zizyphus mauritiana* Lamk) cultivars. Annals of Aridzone 18 : 165-169.

Zora Singh and Sandhu A S 1984 a Effect of time of pruning on growth, flowering, fruit set and maturity in "Umran" Jujube. Indian Journal of Agricultural Science 54 : 688-689.

Zora Singh and Sandhu A S 1984 b Effect of pruning time on productivity and physico-chemical characters of ber (*Zizyphus mauritiana* Lamk) cv. Umran. Journal of Research, Punjab Agricultural University 21 : 521-574.

***Originals not seen**

Appendix

APPENDIX - I

Standard week	Period	Temperature °C		Relative humidity (%)		Sunshine Hours	Rainfall (mm)
		Max.	Min	7.16 hours	14.16 hours		
9	March 26-4	35.1	22.7	77	42	9.6	-
10	5-11	35.7	24.2	76	39	9.0	-
11	12-18	36.0	23.2	72	43	9.5	-
12	19-25	36.4	25.0	67	45	9.5	-
13	April 26-1	36.6	25.0	74	46	9.2	-
14	2-8	37.3	24.9	73	36	10.5	-
15	9-15	37.9	25.0	69	37	10.9	-
16	16-22	39.7	27.0	73	40	10.7	-
17	23-29	38.0	26.6	77	41	7.8	21.6(1)
18	May 30-6	39.2	27.1	74	41	10.8	-
19	7-13	37.7	26.1	76	54	8.0	1.2
20	14-20	38.9	26.0	69	45	4.5	3.3(1)
21	21-27	40.7	28.0	57	35	6.5	6.2(1)
22	June 28-3	42.4	29.4	54	31	9.4	-
23	4-10	40.7	28.9	53	36	8.1	26.1(2)
24	11-17	37.1	26.8	51	36	3.4	-
25	18-24	37.5	27.0	67	41	4.7	15.7(2)
26	July 25-1	37.3	27.1	64	41	1.9	6.3(1)
27	2-8	36.0	26.0	67	43	1.9	6.7 (2)
28	9-15	36.6	26.6	66	49	5.1	28.6(2)
29	16-22	34.8	25.2	78	63	5.4	30.2(3)
30	23-29	33.3	23.3	77	58	3.1	34.4(4)

Standard week	Period	Temperature °C		Relative humidity (%)		Sunshine Hours	Rainfall (mm)
		Max.	Min	7.16 hours	14.16 hours		
31	August 30-5	34.0	23.6	82	61	5.3	36.4(4)
32	6-12	33.2	25.3	74	57	2.9	10.8(2)
33	13-19	33.2	24.7	79	65	5.3	132.5(3)
34	20-26	31.3	24.5	89	77	1.9	35.5(3)
35	Sep. 27-2	32.7	24.2	87	63	4.5	45.8(3)
36	3-9	32.5	24.2	90	66	6.3	66.9(4)
37	10-16	33.1	25.1	74	55	4.5	4.9(1)
38	17-23	33.0	24.0	74	56	5.7	17.2(2)
39	24-30	29.8	23.8	93	77	2.5	33.7(4)
40	Oct. 1-7	29.6	24.0	89	81	0.8	5.6(2)
41	8-14	29.4	22.9	92	84	1.1	63.0(6)
42	15-21	26.4	22.7	73	57	7.3	-
43	22-28	32.7	22.1	85	60	5.8	-
44	Nov. 29-4	29.3	22.1	87	72	2.8	140(4)
45	5-11	27.7	22.7	90	80	3.4	93.4(4)
46	12-18	32.8	20.8	82	57	7.8	-
47	19-25	31.4	21.4	84	67	6.9	5.2(1)
48	Dec. 26-2	30.3	19.3	85	55	8.8	2.2
49	3-9	27.9	20.8	82	65	4.3	-
50	10-16	26.7	19.9	87	77	4.7	172.2(4)
51	17-23	28.1	16.0	82	57	8.8	-
52	24-31	27.5	16.3	86	55	6.3	-

Source : Regional Agricultural Research Station, Tirupati.