

**EFFECT OF TIME AND WIDTH OF GIRDLING ON  
FLOWERING, YIELD AND QUALITY OF MANGO  
(*Mangifera indica* L.) cv. ALPHONSO**

**A**

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**BY**

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PARENTS**



**ABSTRACT**

**EFFECT OF TIME AND WIDTH OF GIRDLING ON  
FLOWERING, YIELD AND QUALITY OF MANGO  
(*Mangifera indica* L.) cv. ALPHONSO**

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**ABSTRACT**

The present investigation “Effect of time and width of girdling on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Alphonso” was carried out at two different locations one at Agriculture Experimental Station, Navsari Agricultural University, Paria, Valsad and another at Regional Horticultural Research Station, Navsari Agricultural University, Navsari. The experiment was laid out in Randomized Block Design with factorial concept comparing four levels of girdling width *viz.*, 0.75 cm (W<sub>1</sub>), 1.00 cm (W<sub>2</sub>), 1.25 cm (W<sub>3</sub>) and 1.50 cm (W<sub>4</sub>) and three levels of girdling time *i.e.* 15<sup>th</sup> July (T<sub>1</sub>), 15<sup>th</sup> August (T<sub>2</sub>) and 15<sup>th</sup> September (T<sub>3</sub>) along with control and replicated thrice.

Results of present investigation revealed that percentage of fruit at harvest stage, fruit weight (g), volume of pulp (ml), number of fruits per shoot, yield (kg/plant), yield (t/ha), TSS (<sup>0</sup>Brix), reducing sugars (%), total sugar (%) and lowest titrable acidity (%) content of fruit with carbohydrate content (%) in leaf tissues during 15<sup>th</sup> January and maximum net realization

along with B: C ratio were obtained by 1.50 cm of girdled width ( $W_4$ ) treatment.

Girdling during 15<sup>th</sup> July ( $T_1$ ) levels produced significantly the highest percentage fruit at harvest stage, maximum fruit weight (g), volume of pulp (ml), number of fruits per shoot, yield (kg/plant), yield (t/ha), TSS (<sup>0</sup>Brix), carbohydrate content (%) during 15<sup>th</sup> October and 15<sup>th</sup> January and maximum C: N ratio in leaves during 15<sup>th</sup> January with maximum net realization and higher B: C ratio.

In control *vs* rest of the treatment analysis, treated treatments gave significantly higher fruit set percentage at harvest stage, fruit weight (g), volume of pulp (ml), number of fruit per shoot, yield (kg/plant) and yield (t/ha), TSS (<sup>0</sup>Brix), total sugar (%), lowest acidity (%), carbohydrate content (%) in 15<sup>th</sup> January with maximum net realization and higher B: C ratio as compared to control (un-girdled).

From present study it can be inferred that the girdling during 15<sup>th</sup> July with 1.50 cm width were proved beneficial for improving flowering, fruiting and quality parameters of fruit as well as promoting carbohydrate content, C: N ratio in leaf tissues for maximum net realization and higher B: C ratio of mango cv. Alphonso.



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## C E R T I F I C A T E

This is to certify that the thesis entitled **EFFECT OF TIME AND WIDTH OF GIRDLING ON FLOWERING, YIELD AND QUALITY OF MANGO (*Mangifera indica* L.) cv. ALPHONSO** submitted by **GHADAGE NITISH JAGANNATH** (Reg. No: 1020213002) in partial fulfilment of the requirement for the award of degree of **DOCTOR OF PHILOSOPHY (HORTICULTURE) in FRUIT SCIENCE** of Navsari Agricultural University is a record of bona fide research work carried out by him under my guidance and the thesis has not previously formed on the basis for the award of any degree, diploma or other similar title.

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**Date:** 28/03/2016

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## DECLARATION

This is to declare that whole of the research work reported in the thesis for partial fulfilment of the requirement for the degree of **Doctor of Philosophy (Horticulture)** in subject of **Fruit Science** is the results of investigation done by the undersigned the direct guidance and supervision of **Dr. S. J. PATIL**, Associate Professor, Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari – 396 450 and no part of the work has been submitted for any other degree so far.

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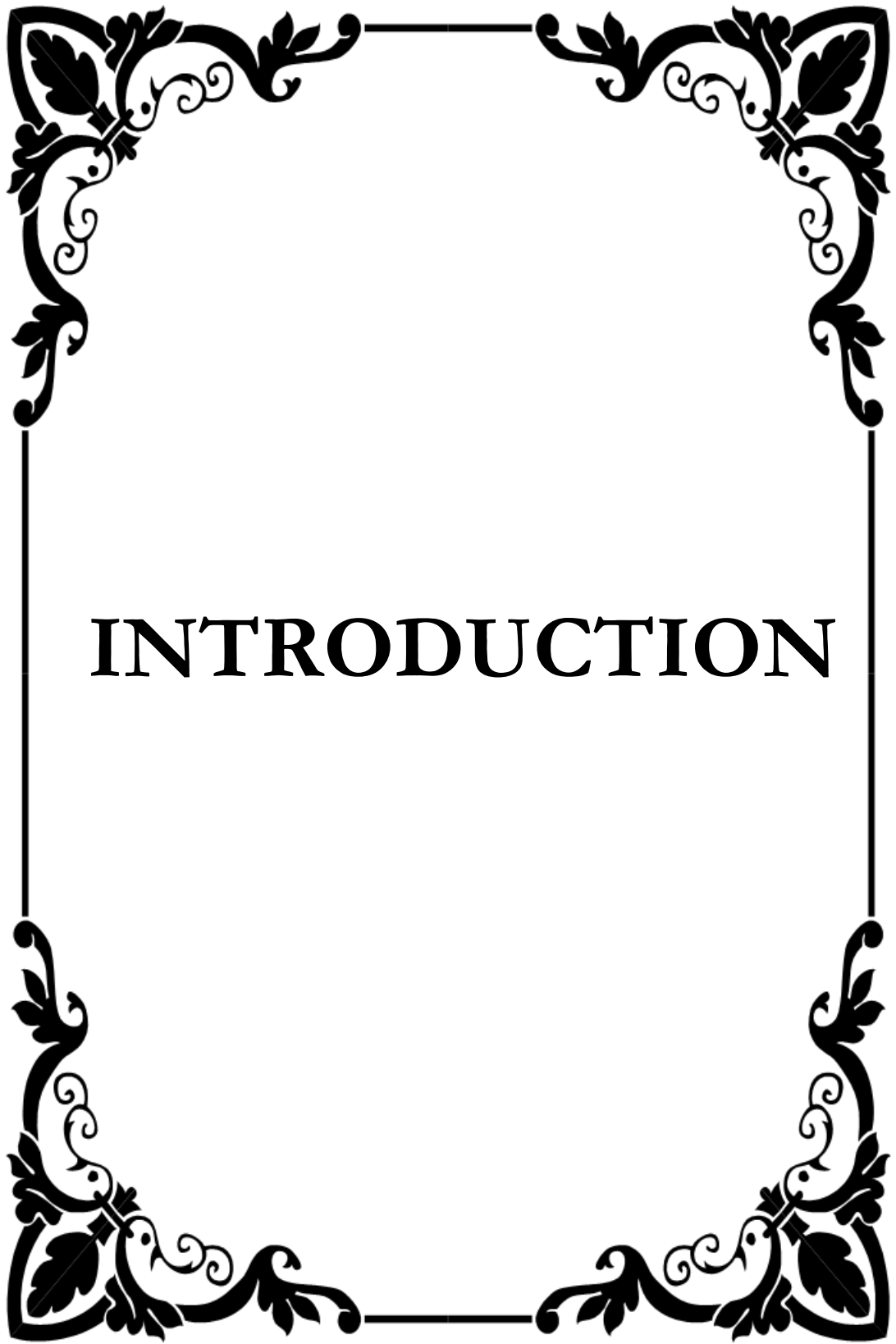
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## ABBREVIATIONS

SR. NO.	ABBREVIATION	MEANING
1	%	Per cent
2	/	Per
3	@	At the rate of
4	X	Multiply
5	:-	Colon and dash
6	( )	Bracket
7	;	Semi colon
8	Max.	Maximum
9	Min.	Minimum
10	Anon.	Anonymous
11	C.D.	Critical difference
12	C.V.	Co-efficient of variance
13	Cm	Centimeter
14	cv.	Cultivar
15	<i>et al.</i>	<i>Et alii</i> (and others)
16	G	Gram(s)
17	<i>i.e.</i>	That is
18	Kg	Kilogram(s)
19	Mg	Milligram
20	Ml	Milliliter
21	No.	Number
22	°C	Degree Centigrade

<b>SR. NO.</b>	<b>ABBREVIATION</b>	<b>MEANING</b>
23	S.Em.±	Standard error of mean
24	Var.	Variety
25	<i>viz.</i>	Such as
26	AES	Agriculture Experimental Station
27	NS	Non-significant
28	Ha.	Hectare
29	MT	Metric Tones
30	DAG	Days After Girdling
31	TSS	Total Soluble Solids
32	Ec	Electrical conductivity
33	pH	Puissance de hydrogen
34	t ha <sup>-1</sup>	Tones per hectare
35	kg tree <sup>-1</sup>	Kilogram per tree
36	COC	Copper oxychloride
37	L.	Linnaeus
38	m <sup>2</sup>	Square meter
39	AM	Ante Meridiem
40	PM	Post Meridiem
41	Mm	Millimeter
42	Km/hr.	Kilometer per hour
43	Ibs	Pound



# INTRODUCTION

## CHAPTER - I

### INTRODUCTION



Mango (*Mangifera indica* L.) unarguably is one of the oldest and choicest sub-tropical fruit of the world and is rightly designated as “King” of all fruits. It is the third widely produced fruit crop of the tropics after banana and citrus and occupying relatively the same position in the tropics as the apple in Europe and North America. Mango is believed to be indigenous to the Indian sub-continent. It is under cultivation in India for more than 4000 years and hence, conspicuous bonds have been formed between the fruit and cultural history of the country.

Mango occupies an important socio-economic position within the religion and culture of India and South East Asian countries, where it is held with high esteem (Singh, 1978). Due to its wide adaptability, high nutritive value, richness in variety, delicious taste, pleasant flavour, attractive appearance, it enjoys the unique popularity among the masses and classes. India still dominates the world production and ranks first with a total production of 18431.3 thousand metric tons from 2516 thousand hectare, which is nearly 43 per cent of the total world area under mango (Anon., 2014).

For our country, it is an important foreign exchange earner, with an earning of Rs. 110.5 crores from the export of 60,551 tons of fresh fruits and Rs. 241.99 crores from the export of 89,514 tons of processed products (Anon., 2012). Uttar Pradesh, Bihar, Andhra Pradesh, Karnataka, Tamil Nadu, Gujarat and Maharashtra are the major mango growing states in India. The successful

implementation of Employment Guarantee Scheme (EGS) linked to horticultural development programme from 1990 onwards, Gujarat state is emerging as the leading mango growing state, currently occupying the area 142.69 thousand ha with a total production of 1125.61 thousand metric tons of mango from productive orchards bearing area of 1.96 lakh ha. Konkan region on the West coast of Maharashtra which comprises four mango growing districts *viz.*, Thane (43,492 ha), Raigad (45,758 ha), Ratnagiri (50,190 ha) and Sindhudurg (25,494 ha) is emerging as one of the largest mango growing belts in the country, occupying 1.65 lakh ha of area under mango (Shrinivasan, 2005), which accounts for about 10 per cent of the total area under mango in the whole of country, of which over 80 per cent is under a single largest growing variety 'Alphonso' locally called as 'Hapus' with a major export share to the tune of over 35 per cent (Anon., 2005).

India has a rich wealth of mango germplasm with more than 1000 mango varieties grown throughout the length and breadth of the country. However, only about 21 of them are commercially cultivated in different mango growing regions (Yadav, 1997). Among them, Alphonso top the list and is grown along the West coast of India in Gujarat, Maharashtra, Goa and Karnataka, which is acclaimed as one of the best Indian mango varieties. It enjoys virtual dominance both in domestic as well as in international markets due to its typical sugar-acid blend, attractive colour and shape, pleasant aroma, highly appreciable flavour, taste and distinctly having long keeping quality. Under changing WTO regime, this variety has recently attracted the attention of APEDA, New Delhi and efforts are on to have international registration for 'Alphonso' mango for IPR norms under geographical indication.

Although, most of the quality merits are confirmed on this variety, it has some serious inherited physiological disorders such as, alternate bearing habit, spongy tissue and excessive/heavy fruit drop at different stages of fruit growth, rendering this variety as poorest yielder (2.5 to 3.5 tons/ha). While, the average productivity among 21 commercially grown varieties in the country is over 7.10 t/ha.

However, excessive fruit drop that occurs at different stages of fruit growth till harvest is considered as one of the long standing unresolved problems, directly and substantially contributing to its poor yield along with other problems. A full grown mango tree in full bearing season ('on' year) produces panicles in thousands, each of which bear about 1000 to 6000 flowers, but only 13 to 28 per cent of these are hermaphrodite, of which, only 0.1 to 0.25 per cent reach to maturity (Kalyanasundaram, 1974). Overall, the final retention in Alphonso mango is reported to be one fruit per 2.5 to 5 panicles (Desai *et al.*, 1984), which is the lowest compared to other commercially cultivated varieties *viz.*, Dasherri (1.35 fruits/panicle), (Chadha and Singh, 1963).

Orchardists have practiced the use of girdling and related techniques in horticulture since last few decades in order to increase the fruit production. The culture of fruit trees is geared toward production of a high-value crop, reduce fruit drop integrating quantity and quality. This is achieved by various techniques; including breeding, nutrition, pest control and bio-regulators as well as direct manipulations of the plant itself. Direct plant manipulations leading to the desired yield consist of two kinds of horticultural techniques. Removal of certain tree organs

(e.g. training, pruning, fruit thinning) and interference with translocation between major tree organs (e.g. girdling, ringing, scoring, branch bending, which modifies auxin distribution, may be included in this second category). Fruit trees might be viewed as a system of sinks and sources (leaves, reproductive organs and roots) interconnected via vascular organs (trunk, branches and scaffold roots). Girdling is basically an intervention in the phloem transport between canopy and roots, in an attempt to manipulate the distribution of photosynthate, mineral nutrients and plant bio-regulators (Goren *et al.*, 2004).

Pattern of movement and distribution of  $^{14}\text{C}$  - photosynthate in mango at various stages of flowering and fruit development, the immediate and most direct reason for the heavy drop of fruit lets is the competition between them for a limit supply of photo-assimilates, as well a competition from developing shoots for these substances. Girdling generally causes an accumulation of carbohydrate above the girdle and a diminution of carbohydrates in the root system (Noel, 1970; Wallerstein *et al.*, 1974 and Wallerstein *et al.*, 1978). It would be there for expected that the number of fruit retained by bearing mango trees would be increased by girdling before fruitlets begin to drop (Chacko, 1984). Wide varieties of fruit species are girdled to induce flowering, improving fruit set, enlarge fruit size, advance maturity and increase yields. Grape, mango, litchi, orange, peach, olive, avocado, apple *etc.* have responded in these areas.

With this back ground, the present study “Effect of time and width of girdling on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Alphonso” was undertaken with the following objectives:

*Introduction*

- 1) To study the effect of time and width of girdling on flowering, yield and quality of mango cv. 'Alphonso'.
- 2) To study the effect of time and width of girdling on nutrient contents of mango leaf cv. 'Alphonso'.
- 3) To find out economic feasibility of treatments.

A decorative rectangular border with ornate floral and scrollwork designs at each corner, framing the central text.

**REVIEW  
OF  
LITERATURE**

## CHAPTER - II

### REVIEW OF LITERATURE



Mango cultivated throughout the tropics and subtropics and mango trees may live for hundreds of years. In spite of profuse number of panicles and a very high initial fruit set in the ‘on’ year, the ultimate retention, harvestable and marketable produce is phenomenally low primary due to heavy fruit drop. In addition, mango fruits are susceptible to physiological disorders that affect the internal fruit quality during ripening. Hence, it is necessary not only to increase the productivity but also to improve the quality of the fruits. Keeping this in view, investigations were carried out to find out, “Effect of time and width of girdling on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Alphonso”. The literature pertaining to these aspects is presented in this chapter.

Girdling is a useful tool for timely fruit production to exploit better prices. With use of girdling, fruit production can be increased and enlarging the local market base. The research work done by different scientists on use of girdling on different fruit crops is reviewed as under:

#### **Mango:**

Gaskins (1963) studied the girdling effect on mango cv. Saigon, for inducing early fruit bearing at Miami, Florida.

Trees were girdled in month of September to January at monthly interval and recorded that, 40% flowering and fruit set were increased in October girdled than without girdled mango trees, but girdled in January had no effect on flowering and fruit set. Time of girdling determined the effectiveness of the treatments.

Oothuyse (1990) studied the effect of trunk girdling on the number of fruits retained by bearing Haden mango trees at Letsitele Valley in the North-Eastern Transvaal. They girdled trunks of five trees every month from April 17<sup>th</sup> until October 23<sup>rd</sup>. Girdling in mid-July or mid-June *i.e.* one or two months before panicle emergence, was most effective in improving set, number of fruit retained per tree being 192% greater on average than that of the control trees. When trees were girdled in mid-May or mid-April *i.e.* three or four months before panicle emergence, improved fruit set by an average of 125% and also recorded that, girdling at the time of panicle emergence increased set by an average of 66%.

Rakshe *et al.* (2014) studied the effect of stem girdling, root pruning and chemicals on fruiting of mango cv. Alphonso at Dapoli, Western Konkan region, *i.e.* high humid coastal region of Maharashtra. They studied the effect of various treatments like soil application of paclobutrazol, sea water spray, root pruning and stem girdling. Among all the treatments significantly maximum fruit weight was recorded in stem girdling on 15<sup>th</sup> October and foliar spray of sea water.

Shinde *et al.* (2014) studied the effect of ringing on flowering and yield of mango (*Mangifera indica* L.) cv. 'Alphonso'. Trail was conducted at Dapoli, *i.e.* high humid coastal region of Western

Maharashtra. The girdling done in first fortnight of may recorded the minimum shoots per terminal, minimum shoot length, maximum shoot diameter, earliness in fruit maturity and maximum fruit weight with maximum net realization which was at par with girdled in second fortnight of May.

**Avocado:**

Lahav *et al.* (1970) studied the effect of girdling on the productivity of the avocado at Bet Dagan, Israel. Girdled branches of six avocado cultivars taken as a experimental material. They found that the increased yield in avocado could be maintained by repeated girdling.

Lahav *et al.* (1972) studied the effect of girdling on fruit quality, phenology and mineral analysis of the avocado tree cv. 'Fuerte' at Bet Dagan, Israel. They revealed that, girdling in October-November (*i.e.* before onset of flowering) caused early flowering by 60 days in the first season and by 85 days in the second season. It also increased productivity, advanced bearing and produced twice as much fruit yield than un-girdled (control) trees.

Lahav *et al.* (1986) studied the effect of various girdling time in avocado at Bet Dagan, Israel. Results revealed that, girdling in early September was significantly increased flowering percentages (99.2 %), flowering intensity (2.7 %), fruit set percentages from 15 % (control) to 65.4 % and increased number of fruits per plant.

**Fig:**

Hossain and Boyce (2009) studied on fig fruit growth and quality development as affected by phloem stress at University of Malaya, Kuala Lumpur, Malaysia. They took various treatments

namely control (un-ringed), I - shape partial ring (I-SPR), X shape partial ring (X-SPR) and S-shape partial ring (S-SPR) at pre harvest stage. They revealed that, phloem stress was represented by partial bark ringing. However, all girdled branches had significantly increased percentage of flower bud and fruit set, fruit length-diameter, bunch weight, fruit weight, soluble solids content and maturity index than ungirdled trees.

### **Grape:**

Reddy and Prakash (1989) studied the effect of girdling and ethrel treatments on berry weight, colour and quality of 'Gulabi Grape' at Bangalore, Karnataka. They took different girdled treatments like girdled once by a strip 4.8 mm wide a fortnight before berry set, girdled twice (strip removal followed by a knife-cut through the phloem), with or without 250 ppm ethrel. Results revealed that positive interaction of double girdling + 250 ppm ethrel which improved quality of berries and also double girdling (4.8 mm wide + knife line) + 250 ppm ethrel gave significantly highest berry weight (3.75 g), lowest number of green berries in a bunch (6.04%), high TSS (21.00 °B) and also hasten maturity of bunches by about 10 days as compared to control.

Cheema *et al.* (1997) studied the effect of flower thinning, girdling and gibberellic acid and its combinations on fruit quality of Perlette grapes. Experiment was carried out at Punjab Agricultural University, Ludhiana, Punjab. They found that the girdling recorded the highest total soluble solids (20.6%) and lowest juice acidity (0.48%), highest cluster weight, highest fruit yield and superior fruit quality compared to control.

Dhillon and Bindra (1999) studied the response of berry thinning and girdling, alone or in combination on fruit quality improvement of grape at Punjab Agricultural University, Ludhiana, Punjab. The girdling and berry thinning during two different times, *i.e.* at fruit set stage and 10 days after fruit set, resulted the significantly increased with berry thinning + girdling done at fruit set as well as 10 days later and also observed significantly highest bunch weight (360 g) and lowest shot berries (2 %) of grape was significantly increased with girdling practiced 10 days after fruit set. Berry thinning 40 % + girdling after fruit set was produced significantly higher berry weight (2.52 g), TSS (19.3 °B), TSS: Acid ratio (35.0 %) and reducing sugar (17%) compared with the control.

Ahmad and Zargar (2005) studied the effect of trunk girdling, flower thinning, GA<sub>3</sub> and ethephon application on quality characteristics in grape cv. 'Perlette' under temperate Kashmir valley conditions. Results revealed that trunk girdling + GA<sub>3</sub> + ethephon gave significantly highest bunch weight (g), bunch length (cm), bunch compactness (wt./cm), number of berries per bunch, juice content (%) , lowest acidity (%) and flower thinning + trunk girdling + GA<sub>3</sub> + ethephon treatment resulted higher berry weight, bunch diameter/breadth, TSS, total sugars (%) which was at par with trunk girdling + GA<sub>3</sub>.

Abu-Zahra (2010) studied the influence of girdling and GA<sub>3</sub> application on the fruit quality and productivity of cane pruned 'Thompson Seedless' which was evaluated at Jordan. They applied four treatments *viz.*, GA<sub>3</sub>, Girdle, GA<sub>3</sub> + Girdle and control. Results revealed that heavier berries; hastened berry diameter,

highest bunch weigh, larger berries size, bunch weight and length were increased in GA<sub>3</sub> + Girdled berries compared to the control.

Desouza *et al.* (2010) studied the effects of gibberellic acid, bio-stimulant crop set and girdling on the quality of bunches of seedless grape cv. 'Catalunha' at Sao Francisco river valley, Brazil. The treatments were applied: one level of gibberellic acid split in five applications (10, 15, 15, 50 and 50 mg l<sup>-1</sup>), two levels of crop set (0.1 and 0.2%) and trunk girdling, isolated or combined with the other treatments. Results revealed that trunk girdling + gibberellic acid (50 mg l<sup>-1</sup>) recorded significantly maximum berry weight (3.59 g), berry diameter (16.33 mm) and highest yield (6.75 t/ha) as compared to control. However, bunch weight was found significantly higher (295.21 g) in girdling + GA<sub>3</sub> + crop set 0.1%. While, berry length was significantly higher (23.16 mm) in trunk girdling + GA<sub>3</sub> (50 mg L<sup>1</sup>) + crop set 0.2%.

Said (2010) studied the effect of girdling, strapping and ethephon spraying on fruit quality of (*Vitis vinifera*) cv. 'Alphonso Lavalle' at Damanhour University, Egypt and found that girdled and strapped vines (two weeks after petal fall) significantly increased the average bunch weight, berry weight, berry length, berry width and improved quality parameters of grape in terms of TSS, acidity and TSS/acid ratio than control and also results revealed that girdled and strapped combined with ethephon especially at 500 ppm proved most effective in increasing all above studied parameters as compared to untreated control.

Koshita *et al.* (2011) studied the effect of temperature, girdling and leaf shading treatments on coloration and total soluble solids and regulation of skin colour in 'Aki Queen' grapes

at NAFRO, Hiroshima, Japan and recorded that TSS content of the berries of the girdled vines were significantly higher (11.5 °B) than control (9.2 °B).

Rather *et al.* (2011) studied the influence of girdling, thinning and GA<sub>3</sub> on fruit quality and shelf life of grape (*Vitis vinifera*) cv. 'Perlette' at Agra, India and they recorded that, girdling + 40 ppm GA<sub>3</sub> was most effective for improving the quality in terms of total soluble solids (17.47 °B), lowest acidity (2.45 %), total sugar (8.94 %) reducing sugar (10.35 %), and TSS/acid ratio (27.24) than untreated trees (control).

Eltom *et al.* (2014) studied that effect of pre-bud break cane girdling on the physical and phonological development of the inner and outer arm in *Vitis vinifera* L. 'Sauvignon Blanc' at Lincoln University, Christchurch, New Zealand. They found that pre bud break cane girdling resulted a direct influence on bunch architecture; carbohydrate availability to developing grapevine buds were increase by girdling of canes two weeks before bud break and they hypothesise that carbohydrate (CHO) availability at bud break (BB) has a strong influence on IP development, especially during the initial stages of shoot growth when pre-formed IP emerge from dormant buds and may be dependent on reserve CHOs for further branching and development.

### **Litchi:**

Li and Xiao (2001) studied the effect of girdling on 'Nuomici' litchi at Guangdong, China. Treatments did as a spiral girdles were applied with 1.5 rings cut 0.4 cm wide and 5 cm apart during (winters) at 10 days after full bloom of pistillate flowers. Results revealed that the girdling in month of November was

increased flowering and fruiting with shorter panicle length, increased total soluble solids and starch content (%) as compared to untreated (ungirdled) trees.

Rani and Brahmachari (2002) studied the effect of growth substances and girdling on fruit set, fruit drop and quality of litchi (*Litchi chinensis* Sonn.) cv. China at Sabour, Bihar. Results revealed that girdling along with foliar application of GA<sub>3</sub> 100 ppm significantly increased fruit set (37.52%), fruit size (3.67 cm length and 3.19 cm diameter), fruit weight (21.5 g), pulp weight/fruit (16.2 g), TSS (16.2 °B), ascorbic acid (49.3 mg/100 g), sugar/acid ratio (30.57), lowest fruit drop (82.24%) and acidity (0.501%) than untreated (control).

Huang *et al.* (2012) studied the effect of spiral girdling on the fruit setting and development of young litchi trees at Guangdong, China. Results revealed that the spiral girdling significantly increased the fruit weight (25.19 g and 20.76 g), total sugar (14.50 % and 16.70 %) and lowest total acid (1.10% and 1.30%) in ‘Noumici’ and ‘Guiwei’ litchi respectively, over control.

### **Olive:**

Ahmed *et al.* (2009) studied the effect of girdling dates on fruit setting in olive cv. ‘Uslu’ at Islamabad, Pakistan. They studied different girdling treatments at 15 days intervals from 1<sup>st</sup> February to 1<sup>st</sup> March and revealed that girdled at 15<sup>th</sup> February resulted in maximum fruit set percentage (4.81) which were significantly higher than 1<sup>st</sup> March treatment (2.03) and control (0.92). They also observed that girdling done on (15<sup>th</sup> February) was found significantly resulted in higher percentages of perfect

flowers, fruit size, fruit weight, fruit harvest percentage and reduced alternate bearing followed by 1<sup>st</sup> March girdled treatment.

Khalil *et al.* (2012) studied the effect of girdling and plant growth regulators on productivity in olive (*Olea europaea*) at Islamabad, Pakistan and revealed that olive trees had more pronounced to girdled effect to improve the internal hormonal and carbohydrate level of canopy which is responsible for improving number of inflorescence, flower number, fruit set and fruit size than untreated tree in various olive cultivars.

### **Citrus:**

Agusti *et al.* (1992) studied the effect of girdling on alternate bearing in citrus at Valencia, Spain. The experiment was done in the two commercial groves one of the sweet orange cv. 'Salustiana' and other of mandarin cv. 'Satsuma'. They found that the girdled branches increased flowering, number of buds sprouted; all type of shoots increased except vegetative shoots and finally improved productivity of both cultivars than un-girdled trees.

Wright (2000) studied the improvement in fruit size of 'Fairchild' mandarins and 'Lisbon' lemons at University of Arizona, Tucson, Arizona. They studied the different time of girdling like November, March and May. Results showed that significantly higher yield (159.8 Ibs/tree) was obtained from March girdled trees which was 217% increment of yield over control and this was followed by November girdled trees (121.5 Ibs/tree) and May girdled trees (75.0 Ibs/tree) and also recorded that returns per acre in March girdling of mandarins lead to greater profits for the grower following by November and May girdling.

Greenberg (2005) studied the effect of girdling on mandarin at Israel condition; they studied various treatments, GA<sub>3</sub>, trunk girdling, branch girdling, branch girdling + GA<sub>3</sub> and control. Results revealed that 94, 472, 229, 306 and 54 fruits per plant and 15 kg, 62 kg, 33 kg, 42 kg and 9 kg fruits per plant in, GA<sub>3</sub>, trunk girdling, branch girdling, branch girdling + GA<sub>3</sub> and control, respectively. *i.e.* Trunk girdling improves number of fruits per plant (472) and yield of fruits kg per plant (62 kg) as compare to other treatments.

Mostafa and Saleh (2006) studied the response of Balady Mandarin trees to girdling and potassium sprays under sandy soil conditions at National Research Centre, Dokki, Egypt. They recorded the effect of various treatments like control (untreated trees), girdling (3 mm), girdling (3 mm) + 1% potassium nitrate, girdling (3 mm) + 2% potassium nitrate, girdling (3 mm) + 1% di-potassium hydrogen phosphate, girdling (3 mm) + 2% di-potassium hydrogen phosphate. Results revealed that girdling (before blossoming in late December) plus spraying of 2% potassium nitrate (first in April and second in mid-June) had a positive effect on nitrogen (2.53 %), potassium (1.75 %), total carbohydrate (12.36 %) and chlorophyll (384) content in the leaves, which reflected on increasing fruit weight (157 g), number of fruits per tree (412) and yield (65 kg/tree) than untreated trees.

Rivas *et al.* (2006) studied the effect of girdling on carbohydrate availability and fruit-set of citrus at Spain. They recorded that a few days after girdled treatment, increased the soluble sugars content in fruitlets, reduced the daily fruit drop, and thereby diminished abscission and also resulted that low-bearing 'Fortune' mandarin orchards girdled was most effective at

15 days before anthesis and 35 days after anthesis (DAA) which increased yield by 125%, girdled at 35 DAA, increased yield by 28% in high-bearing orchards.

El Khawaga (2007) studied the growth and productivity of Manzanillo olive trees with foliar application of some nutrients and girdling under sandy soil at Giza, Egypt. They took two different treatment combinations like girdling + mixture of micronutrients (containing 0.05 % chelated Zn, Fe and Mn and 0.05 % boric acid) and mixture of macronutrients (containing 0.5 % from each of urea, orthophosphoric acid, potassium sulphate and magnesium sulphate). Bearing branches were girdled at one week before full bloom and nutrients were sprayed four times in the first week of April, May, June and July. Results revealed that spraying of micro and macro nutrients + girdling significantly gave highest flowers/inflorescence (19.6), yield (39.9 kg/tree), mean fruit weight (7.40 g), pulp weight (84.7%), seed weight (15.3%) and oil in pulp (20.73%) over rest of the treatments including control.

Rivas *et al.* (2007) observed that effects of girdling are time-dependent, and that yield can be improved in cultivars of different parthenocarpic ability in two *Citrus* cultivars at Valencia, Spain. Results revealed that, girdling increased carbohydrate accumulation in flowering shoots, delayed fruitlet abscission and increased final fruit set compared to ungirdled plants.

Roussos and Tassis (2011) studied the effect of girdling, nitrogen, zinc and auxin foliar spray applications on mandarin fruit “Nova” quality characteristics at Athens, Greece. Treatments comprised an untreated (control), applications of zinc plus nitrogen, post-bloom auxin application and pre-bloom girdling.

They found that girdled trees slightly increased the antioxidant capacity of the juice while, decreased peel color index, increased sucrose, glucose and fructose concentration than other treatments including control.

Giacobbo *et al.* (2012) observed the fruit set and quality of 'Navelina' oranges under different treatments likewise control, branch girdling, promalin phytohormone (benzyladenine + gibberellins + AG<sub>4</sub> + AG<sub>7</sub>), Boron, Boron + branch girdling, Boron + Promalin and Boron + Promalin + branch girdling. Results revealed that the combination of boron (65 ml/10 litre water) + promalin (50 ml/10 litre water) + branches girdling at fruit set gave highest number of fruits (57/plant) and significantly highest yield (6526.5 kg/ha) over rest of treatments.

**Ber:**

Cotrut and Stanica (2015) studied the effect of tree girdling on some varieties of chinese date (*Ziziphus jujuba* Mill.) at Romania. Girdling treatment applied at the beginning of the flowering season on tree trunk and lateral branches. Results revealed that trunk girdled significantly increased yield by improving fruit set, enlarged fruit size, advanced fruit maturity (earlier harvest by 3 up to 10 days) and reduced number of pickings at harvest than control.

**Jamun:**

Khandekar *et al.* (2011) studied the effect of different girdling techniques on the yield and quality of wax jambu fruits (*Syzygium samarangense*) at Kuala Lumpur, Malaysia. They applied various treatments like I-25%, C, V shaped, I-50% and

100% girdling. Girdling were applied three weeks before flowering every season. Results revealed that the C-shaped girdling technique significantly enhanced the inflorescence development and produced the best results with regard to the fruit retention, fruit size, leaf chlorophyll, faster fruit growth producing the best final fruit length and diameter, number of fruits, mean fruit weight and dry matter in comparison to the control and the other girdling techniques employed. It also improved fruit quality, increased total sugars, total phenolics and anthocyanins content but V-shape girdling increased the total flavonoids 150% more as compared to the control treatment.

Haldankar *et al.* (2014) studied the induction of flowering by girdling in Jamun cv. Konkan Bahadoli at two geological locations. Location A was at Pachora Dist. Jalgaon and Location B was at Konkangaon, Dist. Nashik, Maharashtra. They took five treatments *viz.* deep cut on secondary branches, deep cut on tertiary branches, removal of 3 mm bark on secondary branches, removal of 3 mm bark on tertiary branches and control. Results indicated that tertiary branches were found to be more appropriate location for girdling than secondary branches. Deep cut on tertiary branches was the best treatment of girdling in Jamun for induction of flowering, greater flowering intensity, more number of flowers and fruits per branchlet, reduced period from flowering to harvesting and higher yield as compared to control plants.

**Apple:**

Khandekar *et al.* (2012) studied the effect of different girdling techniques on the growth, development and quality of red wax apple fruits (*Syzygium samarangense*) at Malaysian Agricultural Research and Development Institute, Malaysia. Used I, C, V shaped, 50%, and 100% girdling as a treatments, were applied 2 weeks before flowering. Results showed that the C-shaped girdling technique gave the best results with regard to the fruit setting, chlorophyll content, enhanced faster fruit growth producing the best final fruit length and diameter, in addition it significantly increased yield, juice percentage, leaf dry matter, biomass and TSS content of fruits. It was also observed that 50% girdling decreased fruit drop. V-shaped girdled increased the number of buds and reduced bud drop. The colour development of the fruit peel in 100% girdling was highest among the treatments.

Tuan *et al.* (2012) studied the effect of S-girdling, fruit thinning plus bagging with 2, 4-D application, fruit thinning plus bagging on growth and quality of wax apple fruit at Taiwan region. Girdled (S-Shape) treatment were applied three week before flowering, 2, 4-D were sprayed at the small bud and petal fall stage. Results revealed that S-girdling and 2,4-D application gave the lowest bud drop and fruit drop as compared to untreated control. Moreover, S-girdling enhanced faster fruit growth, producing the best final fruit length and diameter, increased fruit set, fruit weight as well as total soluble solid, reduced fruit cracking and titratable acidity over rest of the treatments.

Zhao *et al.* (2013) studied the influence of girdling and foliar-applied of urea on apple (*Malus domestica* L.) fruit quality at

Shaanxi Province, China. They were applied different treatments of four rates of foliar-applied urea (0, 0.2, 0.5 and 0.8%; *i.e.*, N<sub>0</sub>, N<sub>1</sub>, N<sub>2</sub> and N<sub>3</sub>, respectively) with or without girdling. Result revealed that girdled treatment with foliar-application of urea 0.8% (N<sub>3</sub>) significantly increased fruit weight, size, contents of soluble sugars, vitamin C and total amino acids, while it decreased soluble protein content and titratable acidity as well as activities of alcohol acyltransferase and alcohol dehydrogenase than over rest of the treatments including control (untreated).

**Pear:**

Fayek *et al.* (2011) studied the effect of different tree ringing and amino acids foliar spray treatments to improve flowering, fruit set and fruit characteristics of Le Conte pear trees at Cairo University, Giza, Egypt. Results revealed that main branches ringing and one g/L amino acids foliar spray with trunk ringing resulted significantly highest number of floral spurs/m and number of flowers/spur, increased initial fruit set, highest final fruit set, fruit weight and yield compared to the control trees.

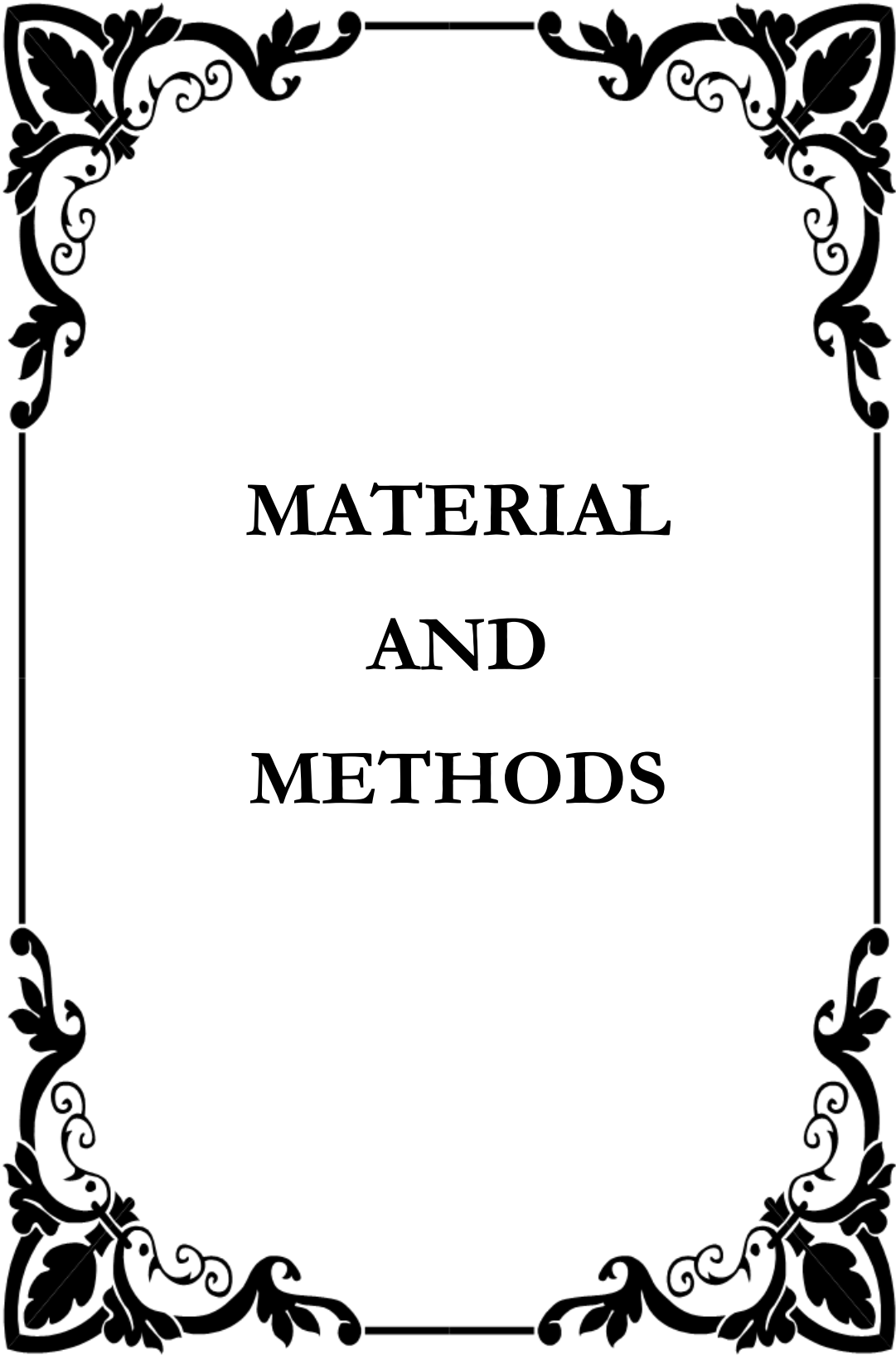
**Peach:**

Day and DeJong (1990) improving fruit size through thinning and girdling nectarines, peaches and plums at University of California, Davis State and found that the optimum response of girdling was obtained on 31<sup>st</sup> March which significantly increased the fruit weight (97.8 g) and soluble solid concentrate (14.2 %) and per cent first picking (89.6%) as compared to control.

Onguso *et al.* (2004) studied the effects of partial ringing and heating of trunk on shoot growth and fruit quality of peach trees.

The experiment was conducted at the Ehime University, Southern Japan. They studied on two different treatments of phloem stress. A 4 cm wide partial ring of bark was removed at a height of 25 cm from the ground leaving a connecting strip of 5 mm and the debarked spot was heated at 150°C for fifteen minutes using an electric heater. Results revealed that the partial girdling was found effective in reducing shoot growth and improving fruit quality and they also observed that the heating had little additive effects over partial ringing in peach.

Hossain *et al.* (2006) studied on development of fruit quality by maintaining partially ringed bark strips peach var. Hikawahakuho at Ehime University, Ehime, Japan. They conducted two different experiment on different size of bark ringing, bark ringing was done on the trunk 4 cm long leaving a connecting strip of bark 2 mm wide (Experiment I) and 5 mm wide (Experiment II). Results revealed that, flower bud percentage, fruit weight, soluble solid content was higher and acid content was lower in partially ringed trees than control and they also found that the trunk circumference was higher in the above ring and lower in the below ring of partially ringed trees.



**MATERIAL  
AND  
METHODS**

## CHAPTER - III

### MATERIAL AND METHODS



Mango is one of the important and prestigious fruit crop in India. In spite of adequate flowering, low fruit yield in mango orchards have been experienced because of low initial fruit set and subsequently higher fruitlet abscission. In addition, late flowering and late fruit production with low quality is another serious problem which affects the foreign exchange earnings. Hence, it is necessary not only to enhance the productivity potential but also help in maintaining the quality of the fruits. Keeping this in view, the present investigation was carried out to find out the “Effect of time and width of girdling on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Alphonso”.

#### **3.1 Geographical Location**

The experiment was conducted at two different locations.

##### **3.1.1 Location - I**

The experiment was conducted at Agriculture Experimental Station, Navsari Agricultural University, Paria, which is situated in Valsad district of Gujarat state at elevation of 10 meter above mean sea level latitude of 20<sup>0</sup>.44' N and east 72<sup>0</sup>.94' E longitude. Site is 10 kilometers away from seashore.

##### **3.1.2 Location - II**

Regional Horticultural Research Station, Navsari Agricultural University, Navsari. Geographically Navsari is situated at 20<sup>0</sup>.92'N latitude and 72<sup>0</sup>.89'E longitude and at an elevation of 13 meter above mean sea level. Location is about 11 kilometres in East away

from Arabian sea shore, the historical place of Dandi famous for Salt Satyagrah in Indian freedom history. Navsari Agricultural University, Navsari is situated 3 km away from Navsari town.

### **3.2 Climate and Weather**

#### **3.2.1 Location - I**

The climate of this area is typically tropical, characterized by fairly hot and humid summer, warm monsoon with more humidity and moderately cold winter. The rainfall in this zone is heavy and normally received from South-West monsoon commences from second week of June up to end of September. The annual mean precipitation of this region is 1500 -2000 mm in 50 rainy days and grouped under South Gujarat Heavy Rainfall Zone (I). July and August are months of heavy precipitation. Temperature ranges in rainy season is 20° to 30°C.

The winter season usually sets by the end of October. The temperature starts declining in beginning of November and continues till the middle of February. The temperature becomes lowest in months of December and January. Frost is rarely occurrence in this area.

The summer commences from mid February and prolongs up to first fortnight of June. The temperature rising from February onwards. April and May are the hottest months of the year.

The meteorological data in respect of maximum and minimum temperature, mean relative humidity, rain fall and sunshine hours recorded at Meteorological Observatory of Agriculture Experimental Station, Navsari Agricultural University Paria during course of investigation from June 2014 to June 2015 presented in Appendix-I.

### **3.2.2 Location - II**

The climate of the region where Navsari Agricultural University situated is typically tropical, characterized by three well defined season's *viz.*, hot summer, mild winter and warm and humid monsoon. The monsoon commences from the second week of June and last up to end of September realized entirely from South-West monsoon. Partial fail over of rains once in three to four years is common in the area. July and August are the months of heavy precipitation. The climate of this area is humid and the mean relative humidity remained above 68.27 per cent through the year. The temperature during most part of the rainy season ranges from 20° to 30°C. The temperature starts dropping in the beginning of November and continues till the middle of February. January and part of February are the coldest months and April and May are the hottest months of the year.

The meteorological data in respect of maximum and minimum temperatures, relative humidity and rainfall distribution, recorded from Meteorological Observatory of College Farm, N. M. College of Agriculture, Navsari during the course of investigation from June 2014 to June 2015 have been presented in Appendix II.

### **3.3 Soil Characteristics:**

#### **3.3.1 Location - I**

Experimental site having a well drained alluvial to black soil. The soils in this agro-climatic zone are medium to deep with high clay content mainly belong to Entisols, Inceptisols and Vertisols. The permeability of the soils is low to very low. They are alkaline in nature and salt affected in the coastal area. They are low to medium in nitrogen, medium to high in phosphorus and sufficient in potash. The soil of the station contains 7.45 pH with 0.35 Ec.

### **3.3.2 Location - II**

As per the seventh approximation, the soil of Navsari has been placed under the great group of vertic ustocherpts, sub order chrepts and order inceptisols with Jalalpore series, which include deep, moderately drained clayey soil, which was classified earlier as “Deep Black Soil”.

The soil of experimental site is black, deep and rich in organic matter and potash, having good water holding capacity with good drainage. The soil of the station contains 7.36 pH with 0.59 Ec.

## **3.4 Experimental Details**

### **3.4.1 Experimental Design**

The experiment was laid out in Randomized Block Design with Factorial concept (F-RBD) with three replications.

### **3.4.2 Experimental Material**

About twenty five year old almost uniform mango trees of Alphonso planted at 10 x 10 m and managed with improved cultural practices with respect to manures and fertilizers, irrigation, plant protection measures *etc.* as per the recommendations were followed in the experimental plot.

The recommended fertilizer dose of 750: 160: 750 g NPK per plant was applied. Nitrogen in form of urea was applied in two equal splits *i.e.* first in the last week of June and 2<sup>nd</sup> at pea stage. Phosphorous and potash were applied in form of single super phosphate and muriate of potash, respectively in June.

### **3.4.3 Method of Girdling**

Girdling practiced mainly on secondary branches (50-60%) of the plants. Selected healthy plants having five or more than five secondary branches. Use of sharp pruning saw and small scale measurement tape for measurement of proper width of girdled portion. Girdling were done very carefully without damage of xylem tissue, only cut were made between peel and xylem. After girdling, applied the copper oxychloride 50 % WP paste was applied on girdled portion for protection from the fungal infections.

### **3.4.4 Harvesting of Fruits**

Fully mature fruits of 'Alphonso' mango were harvested from the experimental trees and immediately brought to the laboratory and arranged as per the treatments for further observations.

### **3.4.5 Treatments with all possible combinations + Control**

#### **3.4.5.1 Experimental Details:**

1. Statistical design : Randomized Block Design with Factorial Concept
2. Number of treatments : 12 + 1 (Control) = 13
3. Number of replications : 03
4. Name of the variety : Alphonso
5. Number of trees/  
treatment : 02
6. Total number of plants : 78
7. Planting distance : 10 x 10 m



Plate. 1: Sharp pruning saw used for proper girdling in mango.



Plate. 2: Girdled branch with 1.50 cm width by the use of sharp pruning saw in mango cv. Alphonso

Plate 3: Various stages from girdling to recovering of girdled area by cambium



Girdled branch (15th July)



Application of COC paste (15th July)



Girdled branch before initiation of cambium growth (1 MAG)



Cambium growth at initial stage  
(2 MAG)



25-30 percentage of cambium growth  
(3 MAG)



45-50 percentage of cambium growth  
(4 MAG)



75-80 percentages of camium growth  
(5 MAG)



Girdled area completely covered by cambium layer  
(6 MAG)

**MAG- Months After Girdling**

**3.4.5.2 Treatment details:**

**Factor - A. Width of Girdling (W)**

1.  $W_1$  - 0.75 cm
2.  $W_2$  - 1.00 cm
3.  $W_3$  - 1.25 cm
4.  $W_4$  - 1.50 cm

**Factor - B. Time of Girdling (T)**

1.  $T_1$  - 15<sup>th</sup> July
2.  $T_2$  - 15<sup>th</sup> August
3.  $T_3$  - 15<sup>th</sup> September

**Control –  $W_0T_0$**

**3.4.5.3 Treatment combinations with detail**

$W_0T_0$  – Control

$W_1T_1$  – Girdling on 15<sup>th</sup> July having width 0.75 cm

$W_2T_1$  – Girdling on 15<sup>th</sup> July having width 1.0 cm

$W_3T_1$  – Girdling on 15<sup>th</sup> July having width 1.25 cm

$W_4T_1$  – Girdling on 15<sup>th</sup> July having width 1.5 cm

$W_1T_2$  – Girdling on 15<sup>th</sup> August having width 0.75 cm

$W_2T_2$  – Girdling on 15<sup>th</sup> August having width 1.0 cm

$W_3T_2$  – Girdling on 15<sup>th</sup> August having width 1.25 cm

$W_4T_2$  – Girdling on 15<sup>th</sup> August having width 1.5 cm

$W_1T_3$  – Girdling on 15<sup>th</sup> September having width 0.75 cm

$W_2T_3$  – Girdling on 15<sup>th</sup> September having width 1.0 cm

$W_3T_3$  – Girdling on 15<sup>th</sup> September having width 1.25 cm

$W_4T_3$  – Girdling on 15<sup>th</sup> September having width 1.5 cm

**3.5 Observations Recorded**

**3.5.1 Flowering Parameters**

1. Time of flowering from girdling (Days)
2. Length of flowering shoot (cm)
3. Hermaphrodite to male flower ratio
4. Fruit set (%)
5. Fruit drop (%)
6. Number of fruits/shoot

**3.5.2 Yield Parameters**

1. Days from pea stage to maturity
2. Yield of fruits (kg/plant)
3. Estimated yield of fruits (t/ha)

**3.5.3 Physico-chemical Parameters**

**3.5.3.1 Physical Parameters**

1. Fruit weight (g)
2. Peel weight (g)
3. Volume of pulp (ml)
4. Stone weight (g)
5. Pulp: Peel: Stone ratio

**3.5.3.2 Chemical Parameters**

1. Total Soluble Solid (%)
2. Acidity (%)
3. Ascorbic acid (mg/100g pulp)
4. Reducing sugar (%)
5. Total sugar (%)

#### **3.5.4 Leaf Analysis:**

**At three months interval *i.e.* from girdling treatment to flowering:**

1. Nitrogen (%)
2. Phosphorous (%)
3. Potassium (%)
4. Carbohydrate content (%)

#### **3.6 Flowering Parameters**

The five panicles from all the directions were selected randomly from each tree and recorded different flowering parameters. Particularly for staminate and hermaphrodite flower, the observations were recorded at alternate days and at each counting the newly opened flowers were removed from each selected panicle by forceps. The averages of two trees were taken for calculation per treatment.

##### **3.6.1 Days taken to flowering**

During the period of flowering the experimental trees were regularly visited and when two or three newly emerging panicles appeared on trees, was considered as date of emergence of panicle. For the calculation of days taken to flowering, it was counted from date of pruning to date of appearance of two or three newly emerging panicles and average of two trees were noted.

##### **3.6.2 Percentage of flowering**

Out of 40 selected pruned and tagged shoots number of panicle emerged were counted at full bloom stage and average was calculated as percentage of flowering.

$$\text{Percentage of flowering} = \frac{\text{Number of panicles emerges}}{\text{Total number of shoots pruned and tagged}} \times 100$$

### **3.6.3 Length of flowering panicle (cm)**

Length of the panicle was measured with the help of scale at full bloom stage. It was measured from the point of emergence to the apex of panicle. Five panicles were earmarked for measuring the length of panicle on each tree and average value was calculated from two trees.

### **3.6.4 Staminate flowers/panicle**

Total number of staminate flowers per panicle was counted from the five panicle of all side on each tree and mean value of staminate flowers were calculated

### **3.6.5 Hermaphrodite flowers/panicle**

Total number of hermaphrodite flowers per panicle was counted from the five panicle of each side *i.e.* 20 panicles and mean of hermaphrodite flowers were calculated. Averages of two trees were noted as treatment observations.

### **3.6.6 Sex ratio (Hermaphrodite: Staminate)**

The ratio between hermaphrodites to staminate flowers in the panicle was worked out. On the basis of number of hermaphrodite and staminate flowers.

## **3.7 Fruiting Parameters**

Among 40 tagged panicles, 20 panicles were used for taking fruiting behavior observations. Average of two trees were noted as the treatment observations.

### **3.7.1 Fruit set percentage (at harvest stage)**

The drying of stigma and swelling of ovary are the indications of fruit set; such sign was recorded as set fruit. On the basis of total numbers of hermaphrodite flower, the percent fruit set per panicle was worked out at harvest stage. Average of two trees recorded as the treatment observation.

$$\text{Percentage of fruit set} = \frac{\text{Number of fruits set per panicle}}{\text{Total number of hermaphrodite flowers}} \times 100$$

### **3.7.2 Fruit drop percentage (%)**

The fruit drop percentage was calculated after completion of harvesting of fruits by the use of following formula

$$\text{Percentage of fruit drop} = \frac{\text{Number of fruits at harvest}}{\text{Total number of fruits at initial stage}} \times 100$$

### **3.7.3 Number of fruits per shoot**

The numbers of fruits were counted treatment wise at harvest. The averages of two were expressed as number of fruits per shoot.

### **3.7.4 Maturity days**

The days required for maturity were recorded from fruit set to harvesting and average days were workout.

### **3.7.5 Yield (kg/plant)**

Weight of fruits from each tree were recorded by weighing the samples on electric balance. Average yield of fruit of each treatment was recorded and expressed in kilogram. Average of two trees recorded as the treatment observation.

### **3.7.6 Fruit yield (t/ha)**

Estimated fruit yield was calculated by following formula.

$$\text{Estimated fruit yield (T/ha)} = \frac{\text{Fruit yield per plant (kg)} \times \text{Total number of plants per hectare}}{1000}$$

## **3.8 Quality Parameters**

For this study, fully matured thirty fruits were selected and brought into laboratory for recording different observations.

### **3.8.1 Weight of fruit (g)**

Individual fruit was weighed separately in grams on weighing balance. The average weight of thirty fruit was then calculated in grams.

### **3.8.2 Total soluble solids (<sup>0</sup>Brix)**

It was recorded using a hand refractometer (Erma made, Japan). From selected fruits pulp, peel and stone were separated then pulp was homogenized well in electric mixture. The homogenized pulp was used for determination of TSS with the help of hand refractometer in <sup>0</sup>Brix.

### **3.8.3 Acidity (%)**

The method described by Ranganna (1986) was adopted for estimation of the titrable acidity of fruits. Ten grams of the homogenized pulp was transferred to 100 ml volumetric flask and volume was made up with distilled water. The solution was well mixed and filtered through Whatman No. 1 filter paper and the filtrate was used for titration. Five milliliters of the filtrate was taken in 100 ml conical flasks and titrated against standard

sodium hydroxide using phenolphthalein as an indicator. The titrable acidity was expressed in terms of percentage citric acid equivalent adopting the following formula.

$$\text{Titrable acidity (\%)} = \frac{\text{Titre value} \times \text{Normality of alkali} \times \text{Total volume made up} \times \text{Equivalent weight of citric acid}}{\text{Aliquot taken for estimation} \times \text{Weight of sample} \times 1000} \times 100$$

### **3.8.4 Reducing sugars (%)**

The titrimetric method of Lane and Eylon described by Ranganna (1986) was adopted for estimation of reducing sugar.

#### **Principle of the method**

Invert sugar or reducing sugar reduces copper in the Fehling's solution to red insoluble cuprous oxide. Sugar in a sample was estimated by determining the volume of unknown sugar solution required to complete reducing a measured volume of Fehling's solution.

#### **Reagents used**

1. Fehling's solution A (Polypharma)
2. Fehling's solution B (Polypharma)
3. Lead acetate (45%) (Polypharma)
4. Methylene blue (1%) (Polypharma)

In advance, the mixture of Fehling's solution A and B (5 ml of A and 5 ml of B) was standardized against standard glucose for obtaining glucose equivalents and to arrive at conversion factor.

**Procedure**

Twenty five grams of the pulp was taken in a volumetric flask and 2 millilitre of 45 per cent basic lead acetate solution was added for clarification. After 10 minutes, the solution was de-leaded by adding potassium oxalate crystals in excess (added till excess of crystals remained undissolved) and the volume was made up to a known amount with distilled water and filtered through Whatman No. 1 filter paper. The filtrate was taken in a burette and titrated against boiling Fehling’s mixture (5 ml of Fehling’s solution A + 5 ml of Fehlings solution B) till the blue colour faded. Then 1 ml of methylene blue indicator (1%) was added and titration was continued till the contents attained a brick red colour and titre value was noted. The percentage of reducing sugar was calculated according to following formula.

$$\text{Reducing sugars (\%)} = \frac{\text{Glucose eq. (0.05)} \times \text{Total volume made up}}{\text{Titre} \times \text{Weight of pulp}} \times 100$$

**3.8.5 Non reducing sugars (%)**

Non reducing sugar is calculated by following formula  
 Non reducing sugar (%) = Total sugar (%) - Reducing sugar (%).

**3.8.6 Total sugars (%)**

For estimation of total sugars, the filterate obtained in the above estimation was used. An aliquot from the filtrate was taken and to one-fifth of its volume, hydrochloride acid (1:1) was added and the inversion was carried out at room temperature for 24 hours. Subsequently, the contents were cooled and neutralized with 40 per cent sodium hydroxide using phenolphthalein as an indicator and the final volume was made.

The solution was filtered through Whatman No. 1 filter paper and titration was carried out using filterate as detailed for reducing sugars.

The total sugars content was expressed as percentage in terms of invert sugars according to the formula.

$$\text{Total sugars (\%)} = \frac{\text{Glucose eq. of fehling solution (0.05)} \times \text{Total volume made up} \times \text{Volume made up after inversion}}{\text{Titre} \times \text{Weight of pulp taken} \times \text{Aliquot taken for inversion}} \times 100$$

### 3.8.7 Ascorbic acid (mg/100 g)

Titrimetric method described by Ranganna (1986) was adopted for estimation of the ascorbic acid.

#### **Procedure**

Ten grams of homogenized pulp was taken and transferred to 100 ml volumetric flask. The volume was made up with 4% oxalic acid solution. After 30 minutes, the suspension was filtered through Whatman No.1 filter paper. Before actual titration 2, 6-Dichlorophenol indophenol (Dye solution) was standardized by titrating against standard ascorbic acid solution and the dye factor was calculated. Five ml of the aliquot was taken from the filterate and titrated against standardized dye solution through a burette. The titration was continued till the light pink colour persisted for 15 seconds.

The ascorbic acid content was calculated adopting the following formula.

$$\text{Ascorbic acid mg/100 g pulp} = \frac{\text{Titrate} \times \text{Dye factor} \times \text{Volume made up}}{\text{Aliquot of extract taken for estimation} \times \text{Weight or volume of sample taken for estimation}} \times 100$$

### **3.9 Leaf Analysis:**

#### **3.9.1 Nitrogen (%)**

Total nitrogen of leaf sample was determined by the Micro-Kjeldahl method as per the method given by Johnson and Ulrich (1969).

#### **3.9.2 Phosphorus (%)**

Phosphorus of leaf sample was determined by the method Vanado molybda phosphoric acid yellow colour method as per the method given Johnson and Ulrich (1969).

#### **3.9.3 Potassium (%)**

Potassium content of the leaf samples were determined by flame photometer as per the method given by Johnson and Ulrich (1969).

#### **3.9.4 Carbohydrate content (%)**

Carbohydrate content of the leaf samples were determined by enzymatic method given by AOAC (2000).

### **3.10 Statistical Analysis**

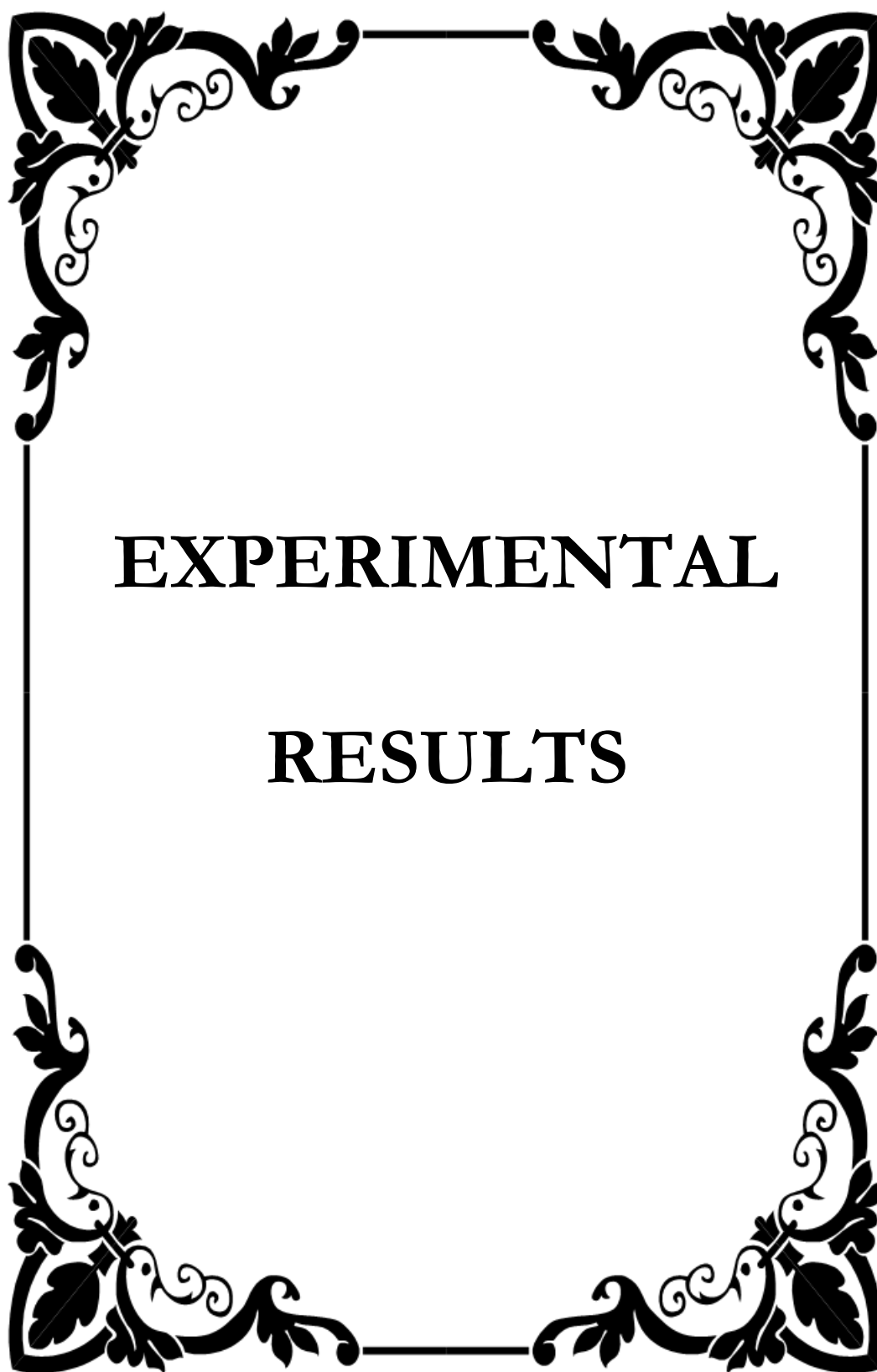
The mean data collected were analyzed statistically as per the procedure for Randomized Block Design with factorial concept (F-RBD) (Panse and Sukhatme, 1985). The treatment mean were compared by the value of critical differences at 5 per cent level of probability and then analyzed statistically in the Department of Agricultural Statistics, N. M. College of Agriculture, Navsari. Twelve treatment combinations due to

four different widths of girdling and three times of girdling (treated) compared with control (untreated) and this comparison shows as control versus treated in result. Pooled analysis of two location data were carried as per procedure suggested by Cochran and Cox (1968).

### **3.11 Economics**

Gross return in terms of rupees per hectare was calculated on the basis of fruit yield and prices in the market for each of the treatments under study. The cost of cultivation for each treatment was worked out by considering the cost of all the operation right from preparation of land to harvesting of crop. Net return was worked out by subtracting the total cost of cultivation from gross realization for each treatment and recorded in rupees per hectare. The net realization was worked out by deducting cultivation cost and the cost required for different treatments from the gross realization per hectare for respective treatments and recorded accordingly.

$$\text{BCR} = \frac{\text{Net realization (Rs/ha)}}{\text{Total cost of cultivation (Rs/ha)}}$$



**EXPERIMENTAL**

**RESULTS**

## CHAPTER - IV

### EXPERIMENTAL RESULTS



In order to achieve a set of objectives, a field experiment “Effect of time and width of girdling on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Alphonso” was undertaken at Agricultural Experimental Station, Navsari Agricultural University, Paria and Regional Horticultural Research Station, Navsari Agricultural University, Navsari during the year 2014-15. The results pertaining to various attributes like, flowering, fruit yield, quality parameters and leaves nutrient analysis have been presented in this chapter which recorded during the course of investigation and were subjected to statistical analysis. The efficacy of various treatments and their combinations were adjudged by comparative assessment of different parameters.

#### **4.1 Flowering parameters**

The mean data on flowering characters *viz.*, days taken to flowering, length of flowering shoots, sex ratio (Hermaphrodite: Staminate), fruit set percentages, fruit drop percentages and days taken from pea stage to maturity as influenced by different girdling width and different time of girdling were recorded during the experimentation and are presented in Table 4.1 to Table 4.6.

##### **4.1.1 Days taken to flowering**

The data on days taken to flowering as affected by different treatments of girdling width and girdling time are presented in Table 4.1.

**Table 4.1: Effect of time and width of girdling on days required for flowering (from girdling) of mango cv. Alphonso**

Treatments	Days taken to flowering			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	124.65	125.12	124.88	
W <sub>2</sub> – 1.00cm	122.30	123.16	122.73	
W <sub>3</sub> – 1.25cm	120.87	121.72	121.29	
W <sub>4</sub> – 1.50cm	116.49	118.26	117.38	
S.Em.±	5.33	6.50	4.20	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	114.76	117.98	116.37	
T <sub>2</sub> – 15 <sup>th</sup> August	122.42	122.79	122.60	
T <sub>3</sub> – 15 <sup>th</sup> September	126.05	125.43	125.74	
S.Em.±	4.61	5.63	3.64	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	9.22	11.26	7.28	
C.D. at 5%	NS	NS	NS	
CV%	13.19	15.97	14.72	
<b>Treated vs Control</b>				
Treated Mean	121.08	122.07	121.57	
Control	130.88	129.29	130.09	
S.Em.±	9.60	11.72	7.57	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	5.94	5.14	10.29	10.71
C.D. at 5%	NS	NS	NS	NS

#### **4.1.1.1 Girdling width**

A perusal of data presented in Table 4.1 revealed that days taken to flowering were failed to showed significant effect affected due to girdling width at both locations and in pooled analysis also.

#### **4.1.1.2 Girdling time**

The data presented in Table 4.1 clearly indicated that different treatments of girdling time failed to exert any significant effect on days taken to flowering from girdling time at Paria and Navsari as well as in pooled analysis also.

#### **4.1.1.3 Effect of interaction**

The interactions effect between  $W \times T$ ,  $L \times W$ ,  $L \times T$ ,  $L \times W \times T$  and  $L \times C \text{ vs } R$  were found non significant on days taken to flowering (Table 4.1).

#### **4.1.1.4 Control vs Rest**

The data presented in Table 4.1 with respect to control vs rest of the treatments did not influenced any significant effect on the days taken to flowering at both the locations and in pooled.

### **4.1.2. Length of flowering shoots (cm)**

The mean data pertaining to length of flowering shoots (cm) as influenced by different girdling time and girdling width are presented in Table 4.2.

#### **4.1.2.1 Girdling width**

A perusal of data presented in Table 4.2 revealed that girdling width did not showed any significant effect on length of flowering shoots (cm).

**Table 4.2: Effect of time and width of girdling on length of flowering shoots (cm) of mango cv. Alphonso**

Treatments		Length of flowering shoots (cm)		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		24.93	25.40	25.17
W <sub>2</sub> – 1.00cm		24.01	24.25	24.13
W <sub>3</sub> – 1.25cm		25.13	25.96	25.55
W <sub>4</sub> – 1.50cm		25.97	25.11	25.54
S.Em.±		1.22	1.21	0.86
C.D. at 5%		NS	NS	NS
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		25.02	25.03	25.03
T <sub>2</sub> – 15 <sup>th</sup> August		25.12	25.22	25.17
T <sub>3</sub> – 15 <sup>th</sup> September		24.64	25.04	24.84
S.Em.±		1.06	1.05	0.74
C.D. at 5%		NS	NS	NS
<b>Interaction effect (W x T)</b>				
S.Em.±		2.12	2.09	1.49
C.D. at 5%		NS	NS	NS
CV%		14.51	14.24	14.42
<b>Treated vs Control</b>				
Treated Mean		25.26	25.43	25.35
Control		23.07	23.75	23.41
S.Em.±		2.20	2.18	1.55
C.D. at 5%		NS	NS	NS
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	1.21	1.05	2.10	2.18
C.D. at 5%	NS	NS	NS	NS

#### **4.1.2.2 Girdling time**

The data presented in Table 4.2 revealed that different treatments of girdling time were failed to exert any significant effect on length of flowering shoots (cm) at both the locations as well as in pooled analysis.

#### **4.1.2.3 Effect of interaction**

The interactions effect between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on length of flowering shoots (Table 4.2).

#### **4.1.2.4 Control *vs* Rest**

A persual of data presented in Table 4.2 indicated that control *vs* rest of the treatments did not influenced any significant effect on panicle length at both the locations as well as in pooled analysis.

### **4.1.3 Sex ratio (Hermaphrodite: Staminate)**

The data pertaining to the effect of different treatments of girdling width and girdling time on sex ratio are presented in Table 4.3.

#### **4.1.3.1 Girdling width**

The data presented in Table 4.3 concealed that different treatments of girdling width did not showed any significant effect on sex ratio. The sex ratio varies from 0.23 to 0.26 in different treatments during both locations as well as in pooled analysis.

**Table 4.3: Effect of time and width of girdling on hermaphrodite to male flower ratio of mango cv. Alphonso**

Treatments	Hermaphrodite to male flower ratio			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	0.24	0.23	0.24	
W <sub>2</sub> – 1.00cm	0.25	0.24	0.25	
W <sub>3</sub> – 1.25cm	0.25	0.24	0.24	
W <sub>4</sub> – 1.50cm	0.26	0.26	0.26	
S.Em.±	0.01	0.01	0.01	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	0.26	0.26	0.26	
T <sub>2</sub> – 15 <sup>th</sup> August	0.25	0.24	0.24	
T <sub>3</sub> – 15 <sup>th</sup> September	0.25	0.23	0.24	
S.Em.±	0.01	0.01	0.01	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.02	0.02	0.01	
C.D. at 5%	NS	NS	NS	
CV%	15.46	14.25	14.64	
<b>Treated vs Control</b>				
Treated Mean	0.25	0.24	0.25	
Control	0.22	0.21	0.21	
S.Em.±	0.02	0.02	0.02	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.012	0.010	0.021	0.022
C.D. at 5%	NS	NS	NS	NS



**Plate. 4: Comparison of flowering with girdled plant and un-girdled (control) plant of mango cv. Alphonso at Paria.**



**Plate 5: Comparison of flowering with girdled plant and un-girdled (control) plant of mango cv. Alphonso at Navs**

#### **4.1.3.2 Girdling time**

A perusal of data presented in Table 4.3 revealed that effect of different treatment of girdling time were failed to show any significant results on sex ratio at both locations as well as in pooled.

#### **4.1.3.3 Effect of interaction**

The interactions effect between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on sex ratio (Table 4.3).

#### **4.1.3.4 Control *vs* Rest**

The data presented in Table 4.3 indicated that control *vs* rest of the treatments did not influenced any significant effect on sex ratio at Paria, Navsari as well as in pooled analysis.

#### **4.1.4 Fruit set percentage (at harvest stage)**

The data on fruit set percentage (at harvest stage) as affected by different treatments of girdling width and girdling time are presented in Table 4.4 and graphically depicted in Fig.1.

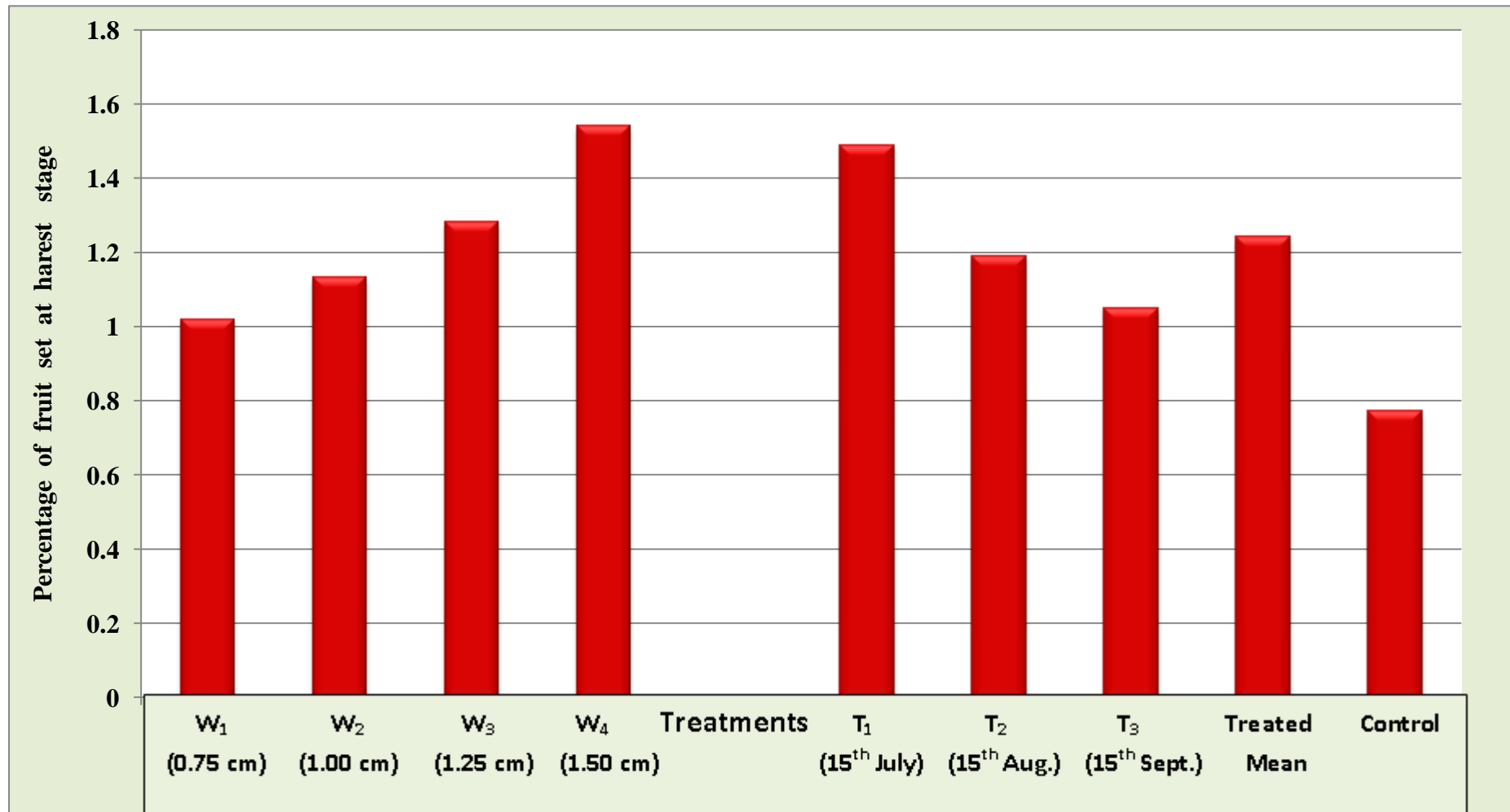
##### **4.1.4.1 Girdling width**

The data pertaining in Table 4.4 noticed that fruit percentage at harvest stage was significantly affected with different girdling widths. Significantly highest fruit percentage was found in 1.50 cm girdling width ( $W_4$ ) treatment at Paria, Navsari and in pooled analysis (1.54, 1.49 and 1.52 %, respectively). While minimum percentage of fruit set was

**Table 4.4: Effect of time and width of girdling on percentage of fruit at harvest stage of mango cv. Alphonso**

Treatments		Percentage of fruit at harvest stage		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		1.02	0.98	1.00
W <sub>2</sub> – 1.00cm		1.13	1.18	1.16
W <sub>3</sub> – 1.25cm		1.28	1.08	1.18
W <sub>4</sub> – 1.50cm		1.54	1.49	1.52
S.Em.±		0.06	0.07	0.05
C.D. at 5%		0.19	0.20	0.13
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		1.49	1.31	1.40
T <sub>2</sub> – 15 <sup>th</sup> August		1.19	1.18	1.19
T <sub>3</sub> – 15 <sup>th</sup> September		1.05	1.05	1.05
S.Em.±		0.06	0.06	0.04
C.D. at 5%		0.16	0.17	0.11
<b>Interaction effect (W x T)</b>				
S.Em.±		0.11	0.12	0.08
C.D. at 5%		NS	NS	NS
CV%		15.37	17.08	15.81
<b>Treated vs Control</b>				
Treated Mean		1.24	1.18	1.21
Control		0.77	0.87	0.82
S.Em.±		0.11	0.12	0.08
C.D. at 5%		0.24	0.25	0.17
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.066	0.057	0.11	0.11
C.D. at 5%	NS	NS	NS	NS

Fig. 1: Effect of time and width of girdling on percentage of fruit at harvest stage of mango cv. Alphonso



observed in 0.75 cm girdling width treatment ( $W_3$ ) treatment (1.02, 0.98 and 1.00 %, respectively) which was at par with  $W_2$  treatment for both the locations.

#### **4.1.4.2 Girdling time**

A perusal of data presented in Table 4.4 revealed that effect of different girdling time were significantly influenced on fruit set percentage at harvest stage. Among the different girdling time, girdling during 15<sup>th</sup> July ( $T_1$ ) treatment produced significantly highest percentage fruit set at harvest stage at both the locations and in pooled analysis (1.49, 1.31 and 1.40 %, respectively) which was at par with  $T_2$  treatment for Navsari location. While, girdling during 15<sup>th</sup> September ( $T_3$ ) treatment produced significantly lowest fruit set percentage at harvest stage at both the locations and in pooled analysis (1.05, 1.05 and 1.05 %, respectively) which was at par with  $T_2$  treatment for Paria and Navsari location.

#### **4.1.4.3 Effect of interaction**

The interactions effect between  $W \times T$ ,  $L \times W$ ,  $L \times T$ ,  $L \times W \times T$  and  $L \times C$  *vs*  $R$  were found non significant on fruit set percentage at harvest stage (Table 4.4).

#### **4.1.4.4 Control *vs* Rest**

The data penetrating in Table 4.4 clearly indicated that control *vs* rest of the treatment showed significant effects on fruit set percentage at harvest stage at both the locations and in pooled analysis. The average fruit set percentage at harvest stage in treated treatment was significantly highest at Paria,

Navsari and pooled analysis (1.24, 1.18 and 1.21 %, respectively).

#### **4.1.5 Fruit drop percentage**

The mean data pertaining to fruit drop percentage as influenced by different girdling width and girdling time are presented in Table 4.5.

##### **4.1.5.1 Girdling width**

The data presented in Table 4.5 concealed that fruit drop percentage were failed to showed any significant effect by different girdling width at Paria and Navsari locations as well as in pooled analysis.

##### **4.1.5.2 Girdling time**

A persual of data presented in Table 4.5 clearly indicated that different girdling time did not influenced any significant effect on fruit drop percentage at both the locations as well as in polled analysis.

##### **4.1.5.3 Effect of interaction**

The interactions effect between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on fruit drop percentage (Table 4.5).

##### **4.1.5.4 Control *vs* Rest**

The data presented in Table 4.5 indicated that control *vs* rest of the treatments did not influenced any significant effect on fruit drop percentage.

Table 4.5: Effect of time and width of girdling on fruit drop (%) of mango cv. Alphonso

Treatments		Fruit drop (%)		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		98.98	99.02	99.00
W <sub>2</sub> – 1.00cm		98.87	98.82	98.84
W <sub>3</sub> – 1.25cm		98.72	98.92	98.82
W <sub>4</sub> – 1.50cm		98.46	98.51	98.48
S.Em.±		4.53	5.08	3.40
C.D. at 5%		NS	NS	NS
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		98.58	98.69	98.63
T <sub>2</sub> – 15 <sup>th</sup> August		98.81	98.82	98.81
T <sub>3</sub> – 15 <sup>th</sup> September		98.95	98.95	98.95
S.Em.±		3.92	4.40	2.95
C.D. at 5%		NS	NS	NS
<b>Interaction effect (W x T)</b>				
S.Em.±		7.84	8.80	5.89
C.D. at 5%		NS	NS	NS
CV%		13.74	15.39	14.61
<b>Treated vs Control</b>				
Treated Mean		98.78	98.82	98.79
Control		99.23	99.07	99.13
S.Em.±		8.16	9.16	6.13
C.D. at 5%		NS	NS	NS
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	4.81	4.16	8.33	8.67
C.D. at 5%	NS	NS	NS	NS

#### **4.1.6 Days taken from pea stage to maturity**

The data on days taken from pea stage to maturity affected by different treatment of girdling width and girdling time are presented in Table 4.6.

##### **4.1.6.1 Girdling width**

The data presented in Table 4.6 clearly indicated that days taken from pea stage to maturity were found non significant results with different girdling width at both the locations and as well as in pooled analysis.

##### **4.1.6.2 Girdling time**

A persual of data presented in Table 4.6 noticed that different treatments of girdling time on days taken from pea stage to maturity were failed to exert any significant difference at both the locations and in pooled analysis.

##### **4.1.6.3 Effect of interaction**

The interactions effect between  $W \times T$ ,  $L \times W$ ,  $L \times T$ ,  $L \times W \times T$  and  $L \times C$  *vs*  $R$  were found non significant on days from pea stage to maturity in all cases (Table 4.6).

##### **4.1.6.4 Control *vs* Rest**

A persual of data presented in Table 4.6 indicated that the control *vs* rest of the treatments analysis did not influenced any significant effect on days from pea stage to maturity at both locations as well as in pooled analysis.

Table 4.6: Effect of time and width of girdling on days required for pea stage to maturity of mango cv. Alphonso

Treatments	Days taken from pea stage to maturity			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	112.43	114.82	113.62	
W <sub>2</sub> – 1.00cm	108.52	111.08	109.80	
W <sub>3</sub> – 1.25cm	107.73	107.54	107.63	
W <sub>4</sub> – 1.50cm	106.08	105.41	105.74	
S.Em.±	4.83	4.42	3.27	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	105.50	106.73	106.12	
T <sub>2</sub> – 15 <sup>th</sup> August	109.15	108.94	109.04	
T <sub>3</sub> – 15 <sup>th</sup> September	111.43	113.47	112.45	
S.Em.±	4.18	3.82	2.83	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	8.36	7.65	5.67	
C.D. at 5%	NS	NS	NS	
CV%	13.33	12.07	12.77	
<b>Treated vs Control</b>				
Treated Mean	108.69	109.71	109.20	
Control	114.82	116.67	115.74	
S.Em.±	8.71	7.96	5.90	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	4.62	4.00	8.01	8.34
C.D. at 5%	NS	NS	NS	NS

## 4.2 Fruiting parameters

The mean data on fruiting characters *viz.*, fruit weight (g), peel weight (g), volume of pulp (ml), stone weight (g), pulp: peel: stone ratio, number of fruits per shoot, fruit yield (kg/plant) and fruit yield (t/ha) as influenced by different treatment of girdling width and girdling time were recorded during experimentation and are presented in Table 4.7 to Table 4.14.

### 4.2.1 Fruit weight (g)

The data pertaining to the effect of different treatments of girdling width and girdling time on fruit weight (g) are presented in Table 4.7 and graphically depicted in Fig.2.

#### 4.2.1.1 Girdling width

The data presented in Table 4.7 indicated that different girdling widths were found significant effect on fruit weight (g). Significantly maximum fruit weight (g) was obtained with 1.50 cm of girdling width ( $W_4$ ) treatment at both the locations and in pooled analysis (307.29, 296.04 and 301.66 g, respectively) which was at par with  $W_3$  treatment for Navsari location. While, minimum fruit weight was noted in 0.75 cm of girdling width ( $W_1$ ) treatment (270.61, 268.44 and 269.53 g, respectively) which was at par with  $W_2$  and  $W_3$  treatments for both the locations and  $W_2$  treatment in pooled analysis.

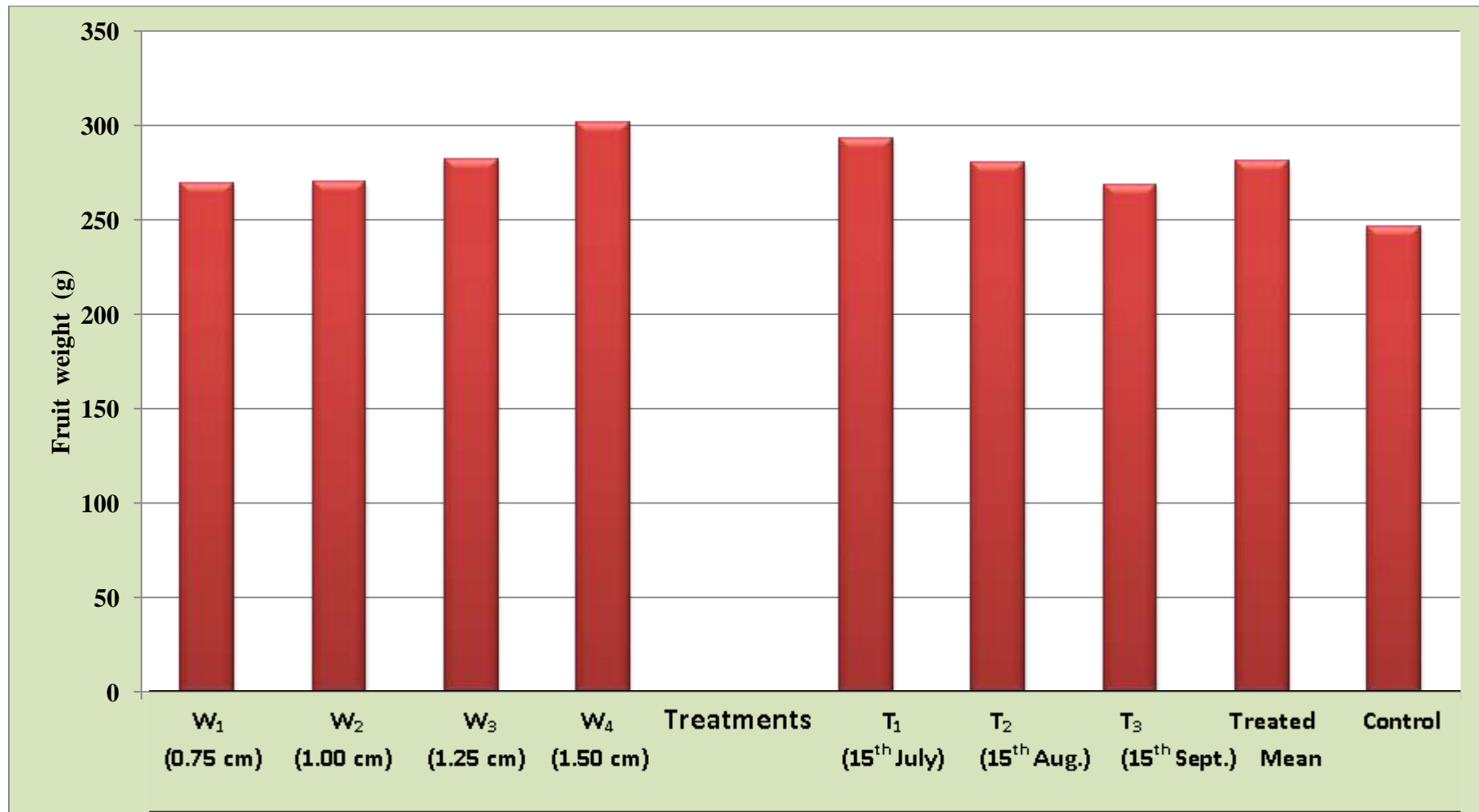
#### 4.2.1.2 Girdling time

A perusal of data presented in Table 4.7 revealed that varying girdling time was significantly affected on fruit weight (g).

Table 4.7: Effect of time and width of girdling on fruit weight (g) of mango cv. Alphonso

Treatments		Fruit weight (g)		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		270.61	268.44	269.53
W <sub>2</sub> – 1.00cm		273.31	267.41	270.36
W <sub>3</sub> – 1.25cm		279.74	285.01	282.37
W <sub>4</sub> – 1.50cm		307.29	296.04	301.66
S.Em.±		5.60	6.29	4.21
C.D. at 5%		16.33	18.36	11.97
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		298.45	288.52	293.49
T <sub>2</sub> – 15 <sup>th</sup> August		279.62	281.62	280.62
T <sub>3</sub> – 15 <sup>th</sup> September		270.13	267.54	268.84
S.Em.±		4.85	5.45	3.65
C.D. at 5%		14.14	15.90	10.37
<b>Interaction effect (W x T)</b>				
S.Em.±		9.69	10.90	7.29
C.D. at 5%		NS	NS	NS
CV%		5.94	6.76	6.40
<b>Treated vs Control</b>				
Treated Mean		282.74	279.22	280.98
Control		244.82	248.64	246.73
S.Em.±		10.09	11.34	7.59
C.D. at 5%		20.82	23.41	15.26
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	5.95	5.15	10.31	10.73
C.D. at 5%	NS	NS	NS	NS

Fig. 2: Effect of time and width of girdling on fruit weight (g) of mango cv. Alphonso



Among different girdling time, girdling during 15<sup>th</sup> July (T<sub>1</sub>) treatment produced significantly maximum fruit weight (g) in both the locations and pooled analysis (298.45, 288.52 and 293.49 g, respectively) which was statistically at par with T<sub>2</sub> treatment for Navsari location and pooled analysis. While, the minimum fruit weight (g) was obtained in girdling during 15<sup>th</sup> September (T<sub>3</sub>) treatment (270.13, 267.54 and 268.84 g, respectively) which was statistically at par with T<sub>2</sub> treatment for both the locations.

#### **4.2.1.3 Effect of interaction**

The data presented in Table 4.7 clearly showed that interaction between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant effect on fruit weight (g).

#### **4.2.1.4 Control *vs* rest**

The data presented in Table 4.7 revealed that control *vs* rest of the treatment analysis were significantly affected with different girdling width and girdling time on fruit weight (g) at both the locations and in pooled analysis. Significantly maximum fruit weight was obtained in treated treatment at Paria, Navsari and pooled analysis (282.74, 279.22 and 280.98 g, respectively).

### **4.2.2 Peel weight (g)**

The data pertaining to the effect of different treatments of girdling width and girdling time on peel weight (g) are presented in Table 4.8.

#### **4.2.2.1 Girdling width**

A persual of data presented in Table 4.8 revealed that treatments of different girdling width were failed to obtain any

Table 4.8: Effect of time and width of girdling on peel weight (g) of mango cv. Alphonso

Treatments	Peel weight (g)			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	51.81	49.29	50.55	
W <sub>2</sub> – 1.00cm	52.06	48.75	50.41	
W <sub>3</sub> – 1.25cm	53.27	50.94	52.11	
W <sub>4</sub> – 1.50cm	55.52	53.05	54.29	
S.Em.±	1.19	1.25	0.86	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	54.36	51.49	52.93	
T <sub>2</sub> – 15 <sup>th</sup> August	53.41	51.21	52.31	
T <sub>3</sub> – 15 <sup>th</sup> September	51.73	48.82	50.28	
S.Em.±	1.03	1.08	0.75	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	2.06	2.17	1.49	
C.D. at 5%	NS	NS	NS	
CV%	6.70	7.43	7.24	
<b>Treated vs Control</b>				
Treated Mean	53.17	50.51	51.84	
Control	48.47	48.31	48.39	
S.Em.±	2.14	2.26	1.55	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	1.21	1.05	2.11	2.19
C.D. at 5%	NS	NS	NS	NS

significant effects on peel weight (g) at both the locations and in pooled analysis.

#### **4.2.2.2 Girdling time**

The data presented in Table 4.8 showed that effect of different treatments of girdling time was failed to exert any significant results on peel weight (g) at both the locations as well as in pooled analysis.

#### **4.2.2.3 Effect of interaction**

The data presented in Table 4.8 clearly showed that interaction effects between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on peel weight (g).

#### **4.2.2.4 Control *vs* Rest**

The control *vs* rest of the treatment did not influenced any significant effect on peel weight (g) in both the locations and in pooled analysis (Table 4.8).

### **4.2.3 Volume of pulp (ml)**

The data pertaining to the effect of different treatments of girdling width and girdling time on volume of pulp (ml) are presented in Table 4.9 and graphically depicted in Fig. 3.

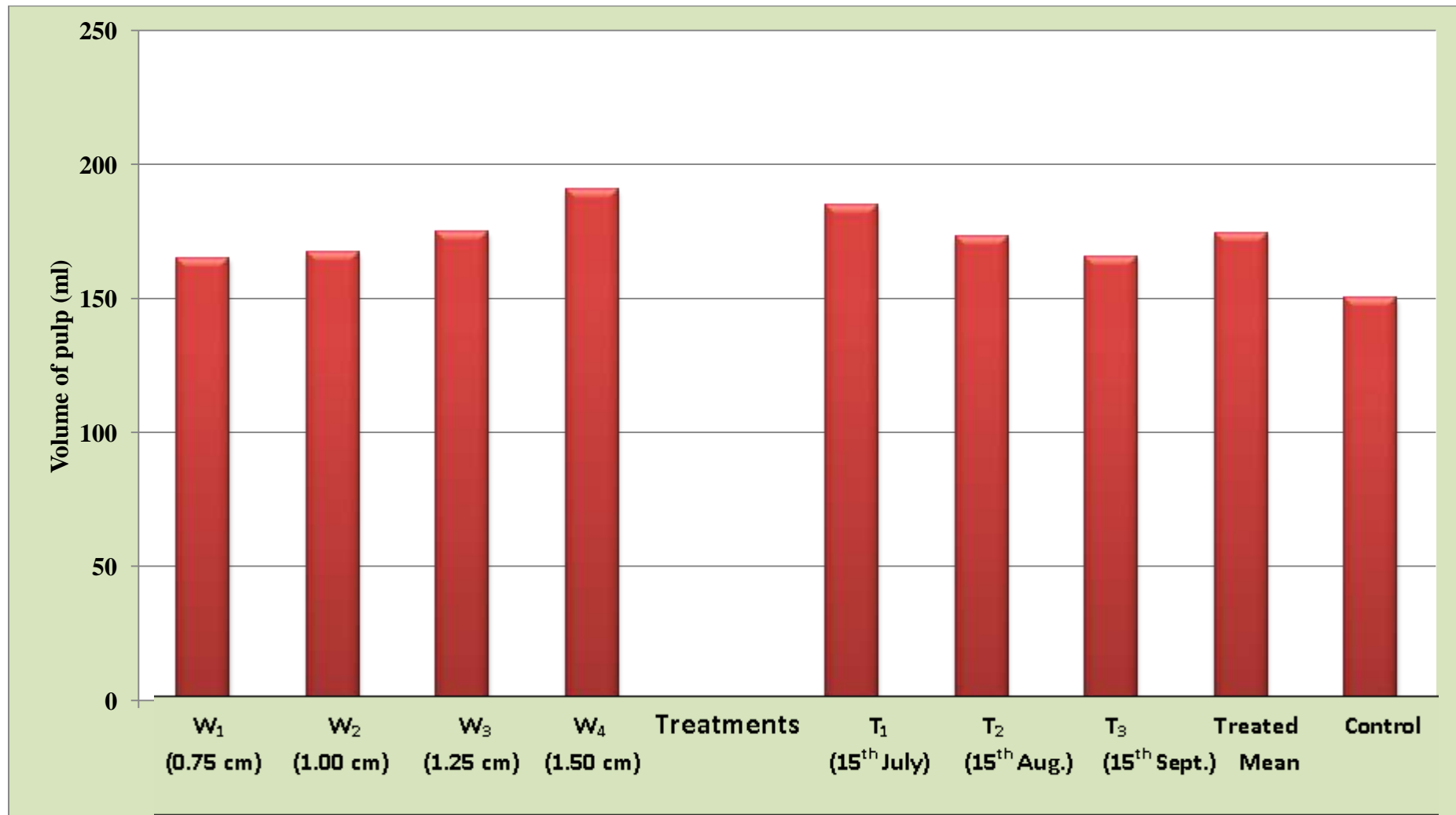
#### **4.2.3.1 Girdling width**

The data presented in Table 4.9 revealed that different treatments of girdling width were significantly affected on volume of pulp (ml). Significantly the maximum volume of pulp (ml) was obtained with 1.50 cm of girdling width (W<sub>4</sub>) treatment in both the locations and in pooled analysis

Table 4.9: Effect of time and width of girdling on volume of pulp (ml) of mango cv. Alphonso

Treatments		Volume of pulp (ml)		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75 cm		165.63	164.41	165.02
W <sub>2</sub> – 1.00 cm		167.41	167.35	167.38
W <sub>3</sub> – 1.25 cm		171.57	178.08	174.82
W <sub>4</sub> – 1.50 cm		193.79	187.31	190.55
S.Em.±		3.70	4.07	2.75
C.D. at 5%		10.81	11.88	7.82
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		187.73	181.73	184.73
T <sub>2</sub> – 15 <sup>th</sup> August		171.12	174.62	172.87
T <sub>3</sub> – 15 <sup>th</sup> September		164.95	166.51	165.73
S.Em.±		3.21	3.52	2.38
C.D. at 5%		9.36	10.29	6.77
<b>Interaction effect (W x T)</b>				
S.Em.±		6.42	7.05	4.77
C.D. at 5%		NS	NS	NS
CV%		6.36	7.00	6.70
<b>Treated vs Control</b>				
Treated Mean		174.60	174.29	174.44
Control		141.95	158.42	150.19
S.Em.±		6.68	7.34	4.96
C.D. at 5%		13.78	15.14	9.97
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	3.89	3.36	6.73	7.01
C.D. at 5%	NS	NS	NS	NS

Fig. 3: Effect of time and width of girdling on volume of pulp (ml) of mango cv. Alphonso



(193.79, 187.31 and 190.55 ml, respectively) which was statistically at par with  $W_3$  treatment for Navsari location. While, minimum volume of pulp (ml) was noted with 0.75 cm of girdling width ( $W_1$ ) treatment (165.63, 164.41 and 165.02 ml, respectively) which was statistically at par with  $W_2$  and  $W_3$  treatments for Paria location and  $W_2$  treatment for Navsari location and in pooled analysis.

#### **4.2.3.2 Girdling time**

A perusal of data presented in Table 4.9 clearly indicate that varying treatments of girdling time were significantly affected on volume of pulp (ml). Among different girdling time, girdling during 15<sup>th</sup> July ( $T_1$ ) produced significantly maximum pulp volume (ml) at both the locations and in pooled analysis. (187.73, 181.73 and 184.73 ml, respectively) which was statistically at par with  $T_2$  treatment for Navsari location. While, the minimum volume of pulp (ml) was obtained in  $T_3$  treatment (164.95, 166.51 and 165.73 ml, respectively) which was statistically at par with  $T_2$  treatment for Paria and Navsari locations.

#### **4.2.3.3 Effect of interaction**

The data presented in Table 4.9 indicated that interaction effects between  $W \times T$ ,  $L \times W$ ,  $L \times T$ ,  $L \times W \times T$  and  $L \times C$  vs  $R$  were found non significant effect on pulp volume (ml).

#### **4.2.3.4 Control vs Rest**

The control *vs* rest of the treatment (Table 4.9) on volume of pulp (ml) were significantly affected with different treatments of girdling width and girdling time. Significantly

maximum volume of pulp (ml) was obtained in treated treatment at both the locations and in pooled analysis (174.60, 174.29 and 174.44 ml, respectively).

#### **4.2.4 Stone weight (g)**

Data pertaining to stone weight (g) as affected by different treatments of girdling width and girdling time on stone weight (g) are presented in Table 4.10.

##### **4.2.4.1 Girdling width**

The data presented in Table 4.10 revealed that different treatments of girdling width did not showed any significant effect on stone weight (g) at both the locations as well as pooled analysis.

##### **4.2.4.2 Girdling time**

The data presented in Table 4.10 indicated that different treatments of girdling time were failed to exert any significant effect on stone weight (g) at both the locations as well as in pooled analysis.

##### **4.2.4.3 Effect of interaction**

The interactions effect between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on stone weight (g) at all cases (Table 4.10).

##### **4.2.4.4 Control *vs* Rest**

It is apparent from the data presented in Table 4.10 revealed that the control *vs* rest of the treatments were failed to exert any significant effect by different treatments of girdling

Table 4.10: Effect of time and width of girdling on stone weight (g) of mango cv. Alphonso

Treatments	Stone weight (g)			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	53.17	51.61	52.39	
W <sub>2</sub> – 1.00cm	53.83	52.43	53.13	
W <sub>3</sub> – 1.25cm	54.45	53.49	53.97	
W <sub>4</sub> – 1.50cm	55.88	54.05	54.97	
S.Em.±	1.21	1.20	0.85	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	55.43	53.69	54.56	
T <sub>2</sub> – 15 <sup>th</sup> August	54.13	52.79	53.46	
T <sub>3</sub> – 15 <sup>th</sup> September	53.45	52.20	52.83	
S.Em.±	1.05	1.04	0.74	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	2.10	2.07	1.47	
C.D. at 5%	NS	NS	NS	
CV%	6.70	6.78	6.83	
<b>Treated vs Control</b>				
Treated Mean	54.33	52.90	53.62	
Control	52.43	51.01	51.72	
S.Em.±	2.19	2.16	1.54	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	1.11	0.96	1.93	2.01
C.D. at 5%	NS	NS	NS	NS

width and girdling time on stone weight (g) at both the locations as well as in pooled analysis.

#### **4.2.5 Pulp: Peel: Stone ratio**

The data pertaining to the effect of different treatments of girdling width and girdling time on pulp: peel: stone ratios are presented in Table 4.11.

##### **4.2.5.1 Girdling width**

A persual of data presented in Table 4.11 indicated that the pulp: peel: stone ratio was found non significant with different girdling width at both the locations and in pooled analysis.

##### **4.2.5.2 Girdling time**

The data presented in Table 4.11 revealed that varying treatments of girdling time were failed to exert any significant effect on pulp: peel: stone ratio at both the locations as well as in pooled analysis.

##### **4.2.5.3 Effect of interaction**

The interactions effect between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on pulp: peel: stone ratio at both the locations as well as in pooled analysis (Table 4.11).

##### **4.2.5.4 Control *vs* Rest**

A persual of data presented in Table 4.11 clearly indicated that the control *vs* rest of the treatments on pulp: peel: stone ratio were failed to exert any significant effects with

Table 4.11: Effect of time and width of girdling on Pulp: Peel: Stone ratio of mango cv. Alphonso

Treatments	Pulp: Peel: Stone ratio			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	0.076	0.072	0.074	
W <sub>2</sub> – 1.00cm	0.086	0.075	0.080	
W <sub>3</sub> – 1.25cm	0.078	0.073	0.075	
W <sub>4</sub> – 1.50cm	0.077	0.073	0.075	
S.Em.±	0.004	0.004	0.003	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	0.082	0.075	0.078	
T <sub>2</sub> – 15 <sup>th</sup> August	0.076	0.071	0.074	
T <sub>3</sub> – 15 <sup>th</sup> September	0.080	0.074	0.077	
S.Em.±	0.003	0.003	0.002	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.007	0.007	0.005	
C.D. at 5%	NS	NS	NS	
CV%	15.126	16.265	15.097	
<b>Treated vs Control</b>				
Treated Mean	0.079	0.073	0.076	
Control	0.074	0.070	0.072	
S.Em.±	0.007	0.007	0.005	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.003	0.003	0.006	0.007
C.D. at 5%	NS	NS	NS	NS

different girdling width and girdling time at both the locations and pooled analysis.

#### **4.2.6 Number of fruits per shoot**

The effect of various girdling width and girdling time on number of fruits per shoot at the time of harvest are presented in Table 4.12 and graphically depicted in Fig. 4.

##### **4.2.6.1 Girdling width**

A perusal of data presented in Table 4.12 revealed that number of fruits per shoot was significantly affected by girdling width. Significantly highest number of fruits per shoot were noted in 1.50 cm of girdling width ( $W_4$ ) treatment at both the locations and in pooled analysis (2.11, 2.00 and 2.06, respectively) which was at par with  $W_3$  treatment for Paria location. While, significantly the lowest number of fruits per shoot were observed in 0.75 cm of girdling width ( $W_1$ ) treatment (1.61, 1.56 and 1.59, respectively) which was at par with  $W_2$  and  $W_3$  treatment for Paria location and pooled analysis and  $W_3$  and  $W_2$  treatment for Navsari location

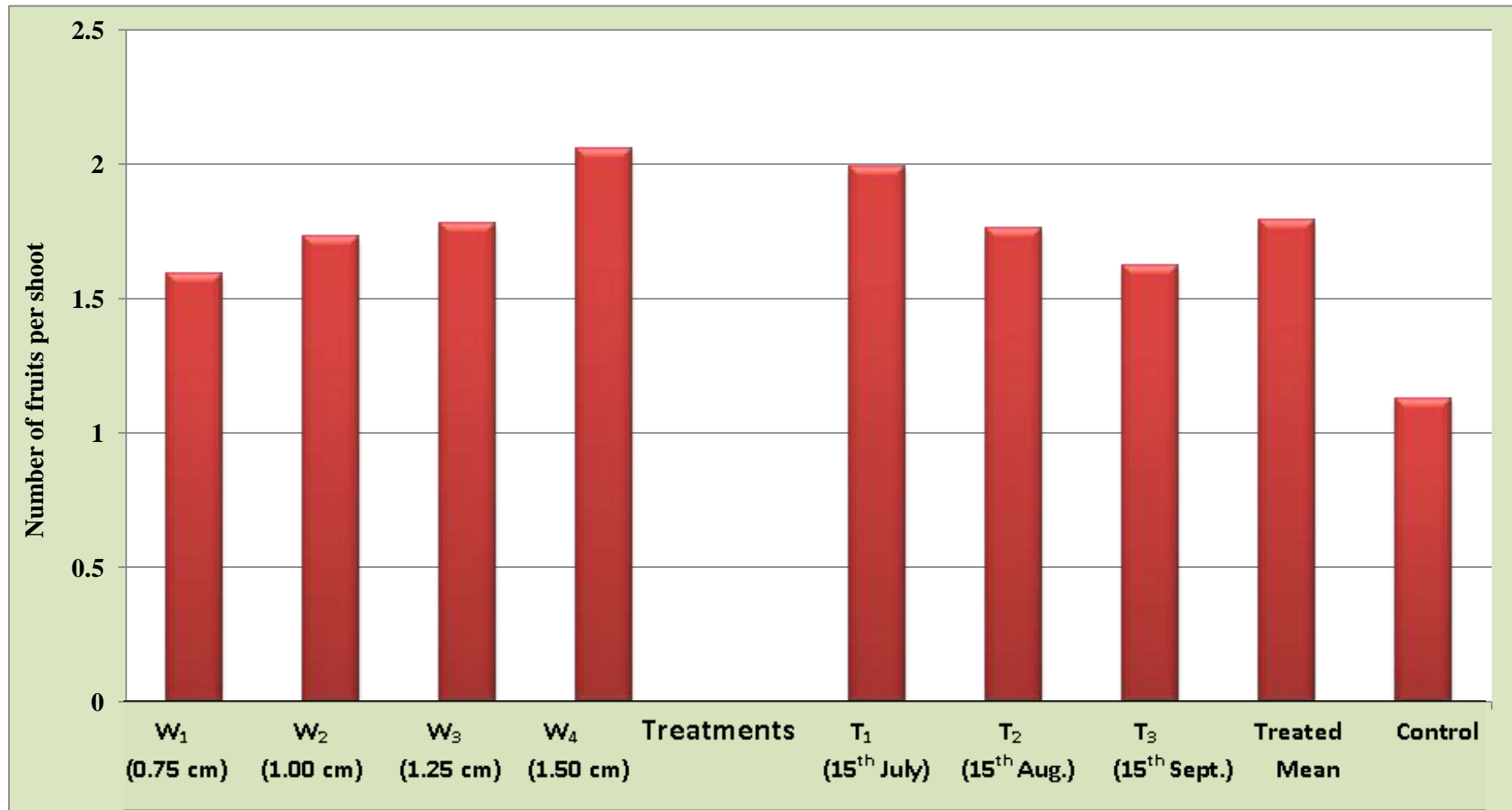
##### **4.2.6.2 Girdling time**

The data presented in Table 4.12 clearly showed that number of fruit per shoot were significantly affected by girdling time at both the locations and in pooled analysis. Among the different girdling time, girdling during 15<sup>th</sup> July ( $T_1$ ) produced significantly highest number of fruits per shoot at both the locations and in pooled analysis (2.06, 1.91 and 1.99, respectively) which was at par with  $T_2$  treatment for Navsari location. While, 15<sup>th</sup> September ( $T_3$ ) produced significantly

**Table 4.12: Effect of time and width of girdling on number of fruits per shoot of mango cv. Alphonso**

Treatments		Number of fruits per shoot		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		1.61	1.56	1.59
W <sub>2</sub> – 1.00cm		1.73	1.73	1.73
W <sub>3</sub> – 1.25cm		1.88	1.68	1.78
W <sub>4</sub> – 1.50cm		2.11	2.00	2.06
S.Em.±		0.10	0.09	0.07
C.D. at 5%		0.28	0.26	0.19
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		2.06	1.91	1.99
T <sub>2</sub> – 15 <sup>th</sup> August		1.79	1.73	1.76
T <sub>3</sub> – 15 <sup>th</sup> September		1.65	1.58	1.62
S.Em.±		0.08	0.08	0.06
C.D. at 5%		0.24	0.22	0.16
<b>Interaction effect (W x T)</b>				
S.Em.±		0.17	0.15	0.11
C.D. at 5%		NS	NS	NS
CV%		15.83	15.14	15.12
<b>Treated vs Control</b>				
Treated Mean		1.83	1.74	1.79
Control		1.13	1.12	1.13
S.Em.±		0.17	0.16	0.12
C.D. at 5%		0.36	0.33	0.24
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.09	0.08	0.16	0.16
C.D. at 5%	NS	NS	NS	NS

Fig. 4: Effect of time and width of girdling on number of fruits per shoot of mango cv. Alphonso



lowest number of fruits per shoot (1.65, 1.58 and 1.62, respectively) which was at par with T<sub>2</sub> treatment for both the locations and in pooled analysis.

#### **4.2.6.3 Effect of interaction**

The interactions effect between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on number of fruit per shoot (Table 4.12).

#### **4.2.6.4 Control *vs* Rest**

The data presented in Table 4.12 indicated that control *vs* rest of the treatments of different girdling width and girdling time were significantly affected on number of fruits per shoots. The treated treatments gave the higher number of fruit per shoot at Paria, Navsari and in pooled analysis (1.83, 1.74 and 1.79, respectively).

#### **4.2.7 Yield (kg/plant)**

The data pertaining to yield (kg/plant) as affected by different treatment of girdling width and girdling time are presented in Table 4.13 and graphically illustrated in Fig.5.

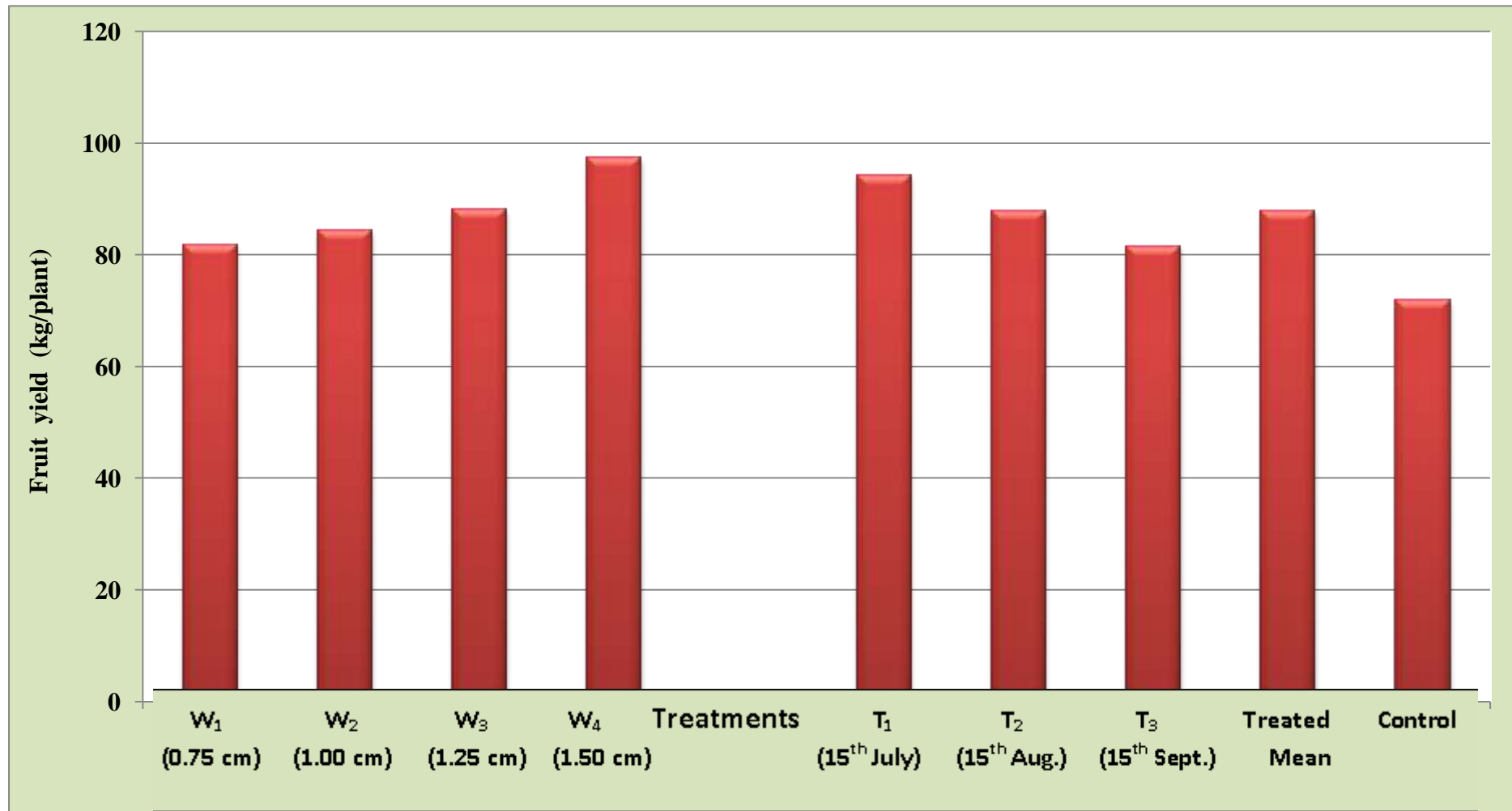
##### **4.2.7.1 Girdling width**

It is evident from the data (Table 4.13) revealed that different treatments of girdling width were significantly affected the yield (kg/plant). Significantly maximum yield (kg/plant) was recorded in 1.50 cm of girdling width (W<sub>4</sub>) treatment at both locations and in pooled analysis (101.75, 93.10 and 97.42 kg/plant, respectively) which was at par with W<sub>3</sub> treatment for

Table 4.13: Effect of time and width of girdling on fruit yield (kg/plant) of mango cv. Alphonso

Treatments	Fruit yield (kg/plant)			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
<b>W<sub>1</sub> – 0.75 cm</b>	82.84	80.66	81.75	
<b>W<sub>2</sub> – 1.00 cm</b>	84.34	84.39	84.37	
<b>W<sub>3</sub> – 1.25 cm</b>	88.02	88.05	88.04	
<b>W<sub>4</sub> – 1.50 cm</b>	101.75	93.10	97.42	
<b>S.Em.±</b>	3.47	2.87	2.25	
<b>C.D. at 5%</b>	10.12	8.38	6.40	
<b>Time of Girdling (T)</b>				
<b>T<sub>1</sub> – 15<sup>th</sup> July</b>	96.79	91.61	94.20	
<b>T<sub>2</sub> – 15<sup>th</sup> August</b>	88.19	87.64	87.91	
<b>T<sub>3</sub> – 15<sup>th</sup> September</b>	82.74	80.40	81.57	
<b>S.Em.±</b>	3.00	2.49	1.95	
<b>C.D. at 5%</b>	8.76	7.26	5.54	
<b>Interaction effect (W x T)</b>				
<b>S.Em.±</b>	6.00	4.98	3.90	
<b>C.D. at 5%</b>	NS	NS	NS	
<b>CV%</b>	11.65	9.96	10.70	
<b>Treated vs Control</b>				
<b>Treated Mean</b>	89.24	86.55	87.89	
<b>Control</b>	72.37	71.41	71.89	
<b>S.Em.±</b>	6.25	5.18	4.06	
<b>C.D. at 5%</b>	12.90	10.69	8.16	
<b>Pooled interaction</b>				
<b>Source</b>	<b>L x W</b>	<b>L x T</b>	<b>L x W x T</b>	<b>Lx (Treated Vs Control)</b>
<b>S.Em.±</b>	3.18	2.75	5.51	5.73
<b>C.D. at 5%</b>	NS	NS	NS	NS

Fig. 5: Effect of time and width of girdling on fruit yield (kg/plant) of mango cv. Alphonso



Navsari location. While, lowest yield was noted in 0.75 cm of girdling width ( $W_1$ ) treatment (82.84, 80.66 and 81.75 kg/plant, respectively) which was at par with  $W_2$  and  $W_3$  treatments for both the locations and in pooled analysis also.

#### 4.2.7.2 Girdling time

A perusal of data presented in Table 4.13 clearly revealed that different treatments of girdling time were significantly affected the yield (kg/plant). Among different girdling time, girdling in 15<sup>th</sup> July ( $T_1$ ) treatment produced significantly maximum yield (kg/plant) at both the locations and in pooled analysis (96.79, 91.61 and 94.20 kg/plant, respectively) which was statistically at par with  $T_2$  treatment for Paria and Navsari locations. While, the minimum yield (kg/plant) was obtained in  $T_3$  treatment (82.74, 80.40 and 81.57 kg/plant, respectively) which was statistically at par with  $T_2$  treatment for both the locations.

#### 4.2.7.3 Effect of interaction

The interaction effects between  $W \times T$ ,  $L \times W$ ,  $L \times T$ ,  $L \times W \times T$  and  $L \times C$  *vs*  $R$  were found non significant on yield kg/plant (Table 4.13).

#### 4.2.7.4 Control *vs* Rest

The data presented in Table 4.13 clearly showed that effect of different girdling width and different girdling time on yield (kg/plant) were significantly affected in control *vs* rest of the treatments analysis. The treated treatment gave highest yield at both the locations and in pooled analysis (89.24, 86.55 and 87.89 kg/plant, respectively).

#### **4.2.8 Yield (t/ha)**

The data pertaining to yield (t/ha) as affected by different treatments of girdling width and girdling time are presented in Table 4.14 and graphically depicted Fig.6.

##### **4.2.8.1 Girdling width**

The data presented in Table 4.14 clearly indicated that different treatments of girdling width were significantly affected the yield (t/ha) at both the locations and in pooled analysis. Significantly the highest yield (t/ha) recorded in 1.50 cm of girdling width ( $W_4$ ) treatment (10.17, 9.31 and 9.74 t/ha, respectively) which was at par with  $W_3$  treatment for Navsari location. While, the lowest yield was noted in 0.75 cm of girdling width ( $W_1$ ) treatment (8.28, 8.07 and 8.18 t/ha, respectively) which was at par with  $W_2$  and  $W_3$  treatments for both the locations and in pooled analysis also.

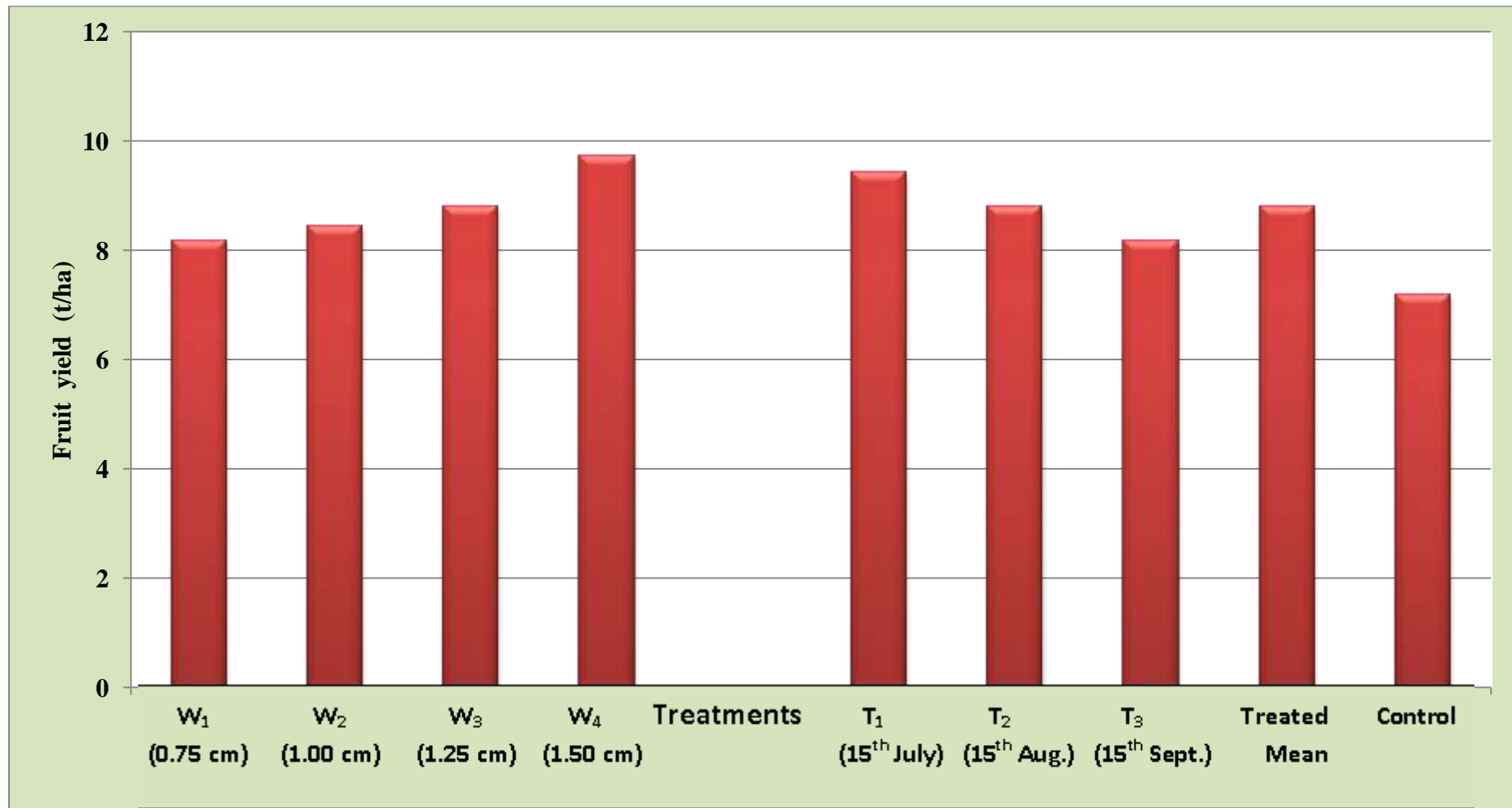
##### **4.2.8.2 Girdling time**

It is apparent from the data (Table 4.14) that different girdling time were significantly affected the yield (t/ha) at both the locations as well as in pooled analysis. Significantly the highest yield (t/ha) was obtained in girdling during 15<sup>th</sup> July ( $T_1$ ) treatment at both the locations and in pooled analysis (9.68, 9.16 and 9.42 t/ha, respectively) which was at par with  $T_2$  treatment for both the locations. While, the lowest yield (t/ha) was obtained in girdling at 15<sup>th</sup> September ( $T_3$ ) treatment (8.27, 8.04 and 8.16 t/ha, respectively) which was at par with  $T_2$  treatment for Paria and Navsari location.

**Table 4.14: Effect of time and width of girdling on fruit yield (t/ha) of mango cv. Alphonso**

Treatments	Fruit yield (t/ha)			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	8.28	8.07	8.18	
W <sub>2</sub> – 1.00cm	8.43	8.44	8.44	
W <sub>3</sub> – 1.25cm	8.80	8.80	8.80	
W <sub>4</sub> – 1.50cm	10.17	9.31	9.74	
S.Em.±	0.35	0.29	0.23	
C.D. at 5%	1.01	0.84	0.64	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	9.68	9.16	9.42	
T <sub>2</sub> – 15 <sup>th</sup> August	8.82	8.76	8.79	
T <sub>3</sub> – 15 <sup>th</sup> September	8.27	8.04	8.16	
S.Em.±	0.30	0.25	0.19	
C.D. at 5%	0.88	0.73	0.55	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.60	0.50	0.39	
C.D. at 5%	NS	NS	NS	
CV%	11.65	9.96	10.70	
<b>Treated vs Control</b>				
Treated Mean	8.92	8.65	8.79	
Control	7.24	7.14	7.19	
S.Em.±	0.62	0.52	0.41	
C.D. at 5%	1.29	1.07	0.82	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.31	0.27	0.55	0.57
C.D. at 5%	NS	NS	NS	NS

Fig. 6: Effect of time and width of girdling on fruit yield (t/ha) of mango cv. Alphonso



#### 4.2.8.3 Effect of interaction

The data presented in Table 4.14 clearly showed that interaction effects between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant effect on fruit yield (t/ha).

#### 4.2.8.4 Control *vs* Rest

The presented data in Table 4.14 showed that different treatment of girdling width and girdling time were significantly affected on control *vs* rest of the treatment analysis. The treated treatments gave significantly higher yield (t/ha) at both locations as well as in pooled analysis (8.92, 8.65 and 8.79 t/ha, respectively).

### 4.3 Quality parameters

The mean data on quality parameters *viz.*, total soluble solid (<sup>0</sup>Brix), acidity (%), ascorbic acid (mg/100 g), reducing sugar (%) and total sugar (%) influenced by different girdling width and girdling time were recorded during the experimentation and are presented in Table 4.15 to Table 4.19.

#### 4.3.1 Total soluble solid (<sup>0</sup>Brix)

The data on total soluble solid (<sup>0</sup>Brix) pertaining to the effect of girdling width and girdling time are presented in Table 4.15 and graphically illustrated in Fig.7.

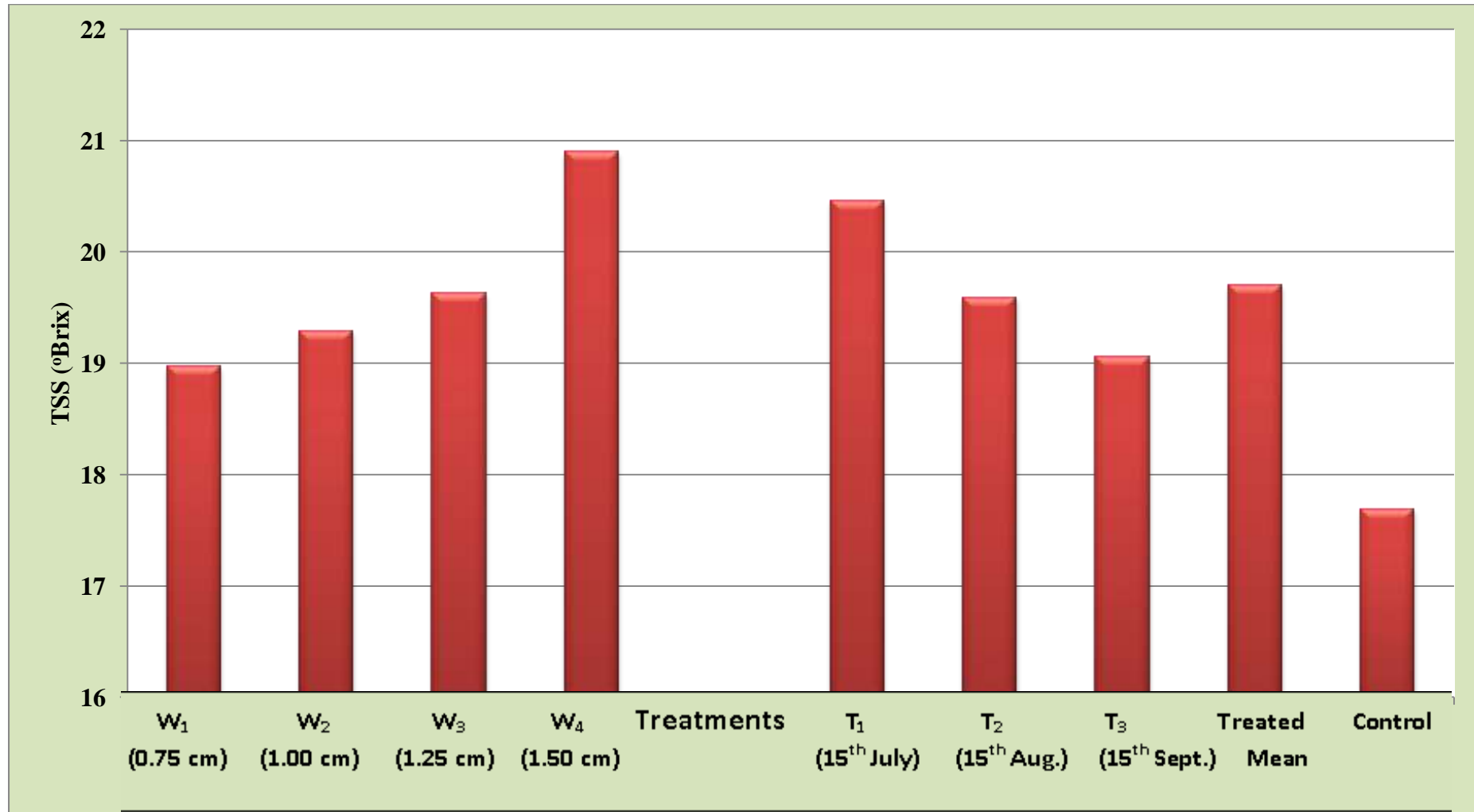
##### 4.3.1.1 Girdling width

The data presented in Table 4.15 revealed that different girdling width were significantly affected by varying girdling width on TSS (<sup>0</sup>Brix). Among different girdling width,

Table 4.15: Effect of time and width of girdling on TSS (°Brix) content of mango fruit cv. Alphonso

Treatments	TSS (°Brix)			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	18.77	19.17	18.97	
W <sub>2</sub> – 1.00cm	19.29	19.29	19.29	
W <sub>3</sub> – 1.25cm	19.98	19.29	19.63	
W <sub>4</sub> – 1.50cm	21.14	20.67	20.90	
S.Em.±	0.41	0.39	0.28	
C.D. at 5%	1.20	1.12	0.80	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	20.64	20.28	20.46	
T <sub>2</sub> – 15 <sup>th</sup> August	19.52	19.65	19.59	
T <sub>3</sub> – 15 <sup>th</sup> September	19.21	18.88	19.05	
S.Em.±	0.36	0.33	0.24	
C.D. at 5%	1.04	0.97	0.69	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.71	0.67	0.49	
C.D. at 5%	NS	NS	NS	
CV%	6.24	5.90	6.04	
<b>Treated vs Control</b>				
Treated Mean	19.79	19.60	19.70	
Control	17.57	17.82	17.69	
S.Em.±	0.74	0.69	0.51	
C.D. at 5%	1.53	1.43	1.02	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.49	0.34	0.69	0.71
C.D. at 5%	NS	NS	NS	NS

Fig. 7: Effect of time and width of girdling on TSS (°Brix) of mango cv. Alphonso



significantly maximum TSS ( $^{\circ}$ Brix) of the fruit was obtained in 1.50 cm of girdling width ( $W_4$ ) treatment at both the locations and pooled analysis (21.14, 20.67 and 20.90  $^{\circ}$ Brix, respectively) which was at par with  $W_3$  treatment for Paria location. While, the minimum TSS ( $^{\circ}$ Brix) was obtained in 0.75 cm girdling width ( $W_1$ ) treatment (18.77, 19.17 and 18.97  $^{\circ}$ Brix, respectively) which was at par with  $W_2$  and  $W_3$  treatments for Navsari location and in pooled analysis and  $W_2$  for Paria location.

#### **4.3.1.2 Girdling time**

It is evident from the data (Table 4.15) that different girdling time were significantly affected on TSS ( $^{\circ}$ Brix). Among different girdling time, girdling during 15<sup>th</sup> July ( $T_1$ ) treatment produced significantly maximum TSS ( $^{\circ}$ Brix) at both the locations and in pooled analysis (20.64, 20.28 and 20.46  $^{\circ}$ Brix, respectively) which was at par with  $T_2$  treatment for Navsari location. While, the minimum TSS ( $^{\circ}$ Brix) was obtained with  $T_3$  treatment (19.21, 18.88 and 19.05  $^{\circ}$ Brix, respectively) which was at par with  $T_2$  treatment for both the locations and pooled analysis.

#### **4.3.1.3 Effect of interaction**

The interaction effect between  $W \times T$ ,  $L \times W$ ,  $L \times T$ ,  $L \times W \times T$  and  $L \times C$  *vs*  $R$  were found non significant on total soluble solid content at both the locations well as in pooled analysis (Table 4.15).

#### **4.3.1.4 Control *vs* Rest**

The data presented in Table 4.15 indicated that the control *vs* rest of the treatments analysis on TSS ( $^{\circ}$ Brix) was significantly affected with different treatment of girdling width

and girdling time at both the locations and in pooled analysis. Significantly maximum TSS (<sup>0</sup>Brix) was obtained in treated treatment at both the locations and pooled analysis (19.79, 19.60, 19.70 <sup>0</sup>Brix, respectively).

#### **4.3.2 Titrable acidity (%)**

The data pertaining to effect of different treatments of girdling width and girdling time on titrable acidity (%) are presented in Table 4.16 and graphically depicted in Fig. 8.

##### **4.3.2.1 Girdling width**

A persual of data presented in Table 4.16 revealed that different treatments girdling width were significantly influenced the titrable acidity (%) content of the fruits. Among different girdling width, significantly the lowest acidity (%) was obtained in 1.50 cm of girdling width ( $W_4$ ) treatment at both the locations and in pooled analysis (0.272, 0.270 and 0.271 %, respectively) which was statistically at par with  $W_3$  treatment for Paria, Navsari and in pooled analysis. While, the highest titrable acidity (%) was obtained in girdling  $W_1$  treatment (0.310, 0.317 and 0.313 %, respectively).

##### **4.3.2.2 Girdling time**

The data penetrating in Table 4.16 indicated that titrable acidity (%) content of the fruits was found non significant by influenced with different girdling time at both the locations as well as in pooled analysis.

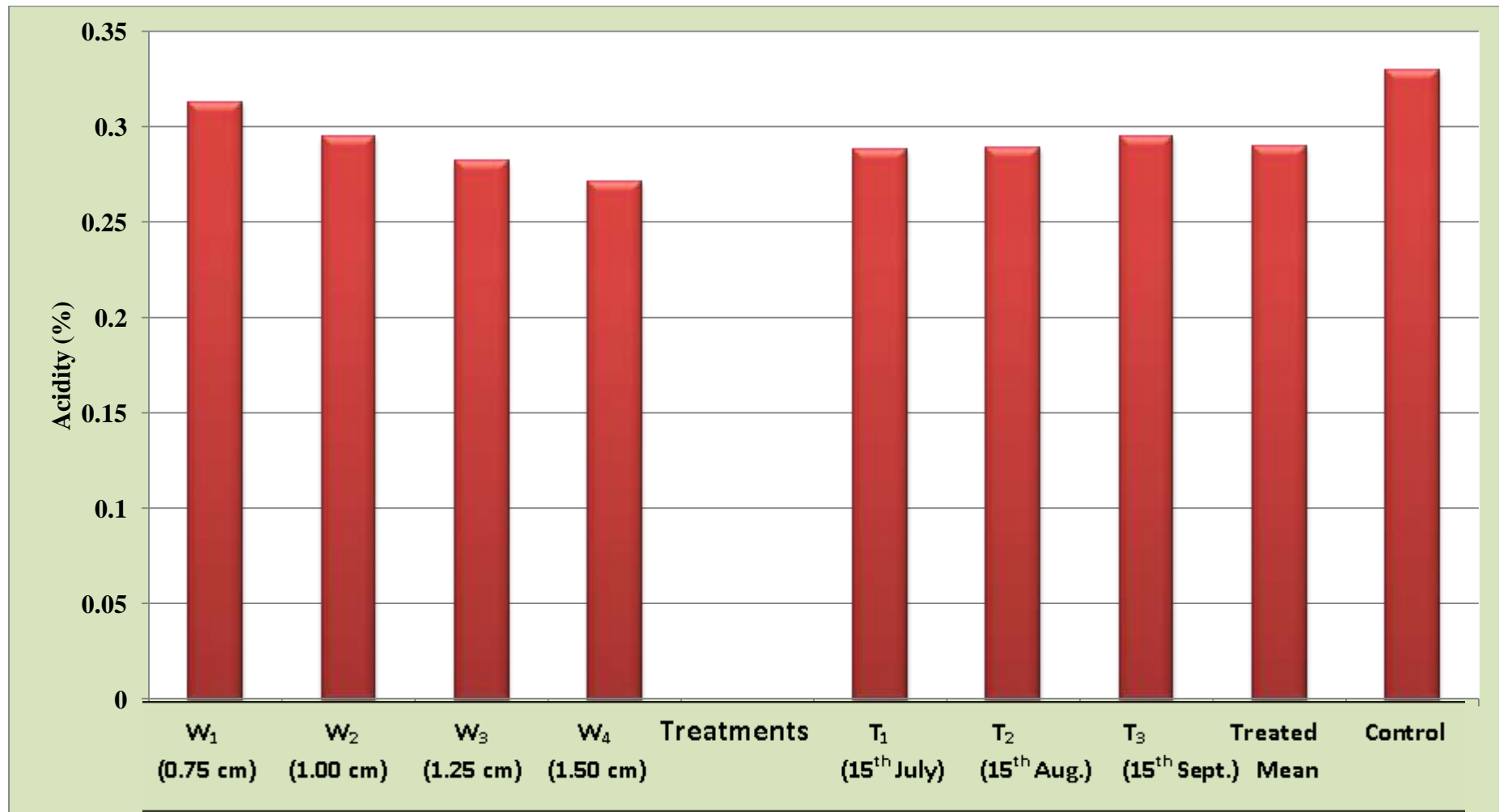
##### **4.3.2.3 Effect of interaction**

The interactions effect between  $W \times T$ ,  $L \times W$ ,  $L \times T$ ,  $L \times W \times T$  and  $L \times C$  vs  $R$  were found non significant on

Table 4.16: Effect of time and width of girdling on titrable acidity (%) content of fruits of mango cv. Alphonso

Treatments	Titrable Acidity (%)			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	0.310	0.317	0.313	
W <sub>2</sub> – 1.00cm	0.293	0.297	0.295	
W <sub>3</sub> – 1.25cm	0.280	0.280	0.282	
W <sub>4</sub> – 1.50cm	0.272	0.270	0.271	
S.Em.±	0.006	0.006	0.004	
C.D. at 5%	0.018	0.016	0.012	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	0.283	0.293	0.288	
T <sub>2</sub> – 15 <sup>th</sup> August	0.288	0.290	0.289	
T <sub>3</sub> – 15 <sup>th</sup> September	0.299	0.295	0.295	
S.Em.±	0.005	0.005	0.004	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.011	0.010	0.007	
C.D. at 5%	NS	NS	NS	
CV%	6.324	5.722	6.059	
<b>Treated vs Control</b>				
Treated Mean	0.289	0.292	0.290	
Control	0.327	0.333	0.330	
S.Em.±	0.011	0.010	0.007	
C.D. at 5%	0.023	0.021	0.015	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.011	0.010	0.020	0.021
C.D. at 5%	NS	NS	NS	NS

Fig. 8: Effect of time and width of girdling on acidity (%) content fruits of mango cv. Alphonso



titrable acidity (%) at both the locations as well as in pooled analysis (Table 4.16).

#### **4.3.2.4 Control vs Rest**

A persual of data presented in Table 4.16 indicated that the control *vs* rest of the treatment analysis on the titrable acidity (%) significantly affected with the different treatments of girdling width and girdling time. Significantly the lowest titrable acidity (%) was obtained in treated treatments at both the locations as well as in pooled analysis (0.289, 0.292 and 0.290 %, respectively).

#### **4.3.3 Ascorbic acid (mg/100 g)**

The data pertaining to the effect of different treatments of girdling width and girdling time on ascorbic acid (mg/100 g) are presented in Table 4.17.

##### **4.3.3.1 Girdling width**

The data described in Table 4.17 clearly indicated that varying treatments of girdling width failed to exert any significant effect on ascorbic acid (mg/100g) at both the locations as well as in pooled analysis.

##### **4.3.3.2 Girdling time**

The data presented in Table 4.17 revealed that different girdling time did not show any significant effect on ascorbic acid (mg/100g) at both the locations as well as in pooled analysis.

Table 4.17: Effect of time and width of girdling on ascorbic acid (mg/100 g) of mango cv. Alphonso

Treatments	Ascorbic acid (mg/100 g)			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	67.95	68.53	68.24	
W <sub>2</sub> – 1.00cm	67.34	67.19	67.27	
W <sub>3</sub> – 1.25cm	68.35	68.62	68.48	
W <sub>4</sub> – 1.50cm	69.28	70.03	69.65	
S.Em.±	0.93	1.21	0.76	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	68.08	67.88	67.98	
T <sub>2</sub> – 15 <sup>th</sup> August	67.78	67.52	67.65	
T <sub>3</sub> – 15 <sup>th</sup> September	68.82	70.38	69.60	
S.Em.±	0.81	1.05	0.66	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	1.62	2.10	1.32	
C.D. at 5%	NS	NS	NS	
CV%	4.10	5.30	4.76	
<b>Treated vs Control</b>				
Treated Mean	68.23	68.59	68.41	
Control	66.68	66.97	66.82	
S.Em.±	1.68	2.19	1.38	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	1.08	0.93	1.87	1.95
C.D. at 5%	NS	NS	NS	NS

#### **4.3.3.3 Effect of interaction**

The interactions effect on ascorbic acid (mg/100g) did not showed any significant between W x T, L x W, L x T, L x W x T and L x C *vs* R (Table 4.17).

#### **4.3.3.4 Control *vs* Rest**

The data presented in Table 4.17 recorded that the control *vs* rest of the treatments did not influenced the any significant effects on ascorbic acid (mg/100 g) content of the fruits at both individual locations as well as in pooled analysis.

#### **4.3.4 Reducing sugars (%)**

The data on reducing sugar (%) as affected by different treatments of girdling width and girdling time are presented in Table 4.18 and graphically depicted in Fig. 9.

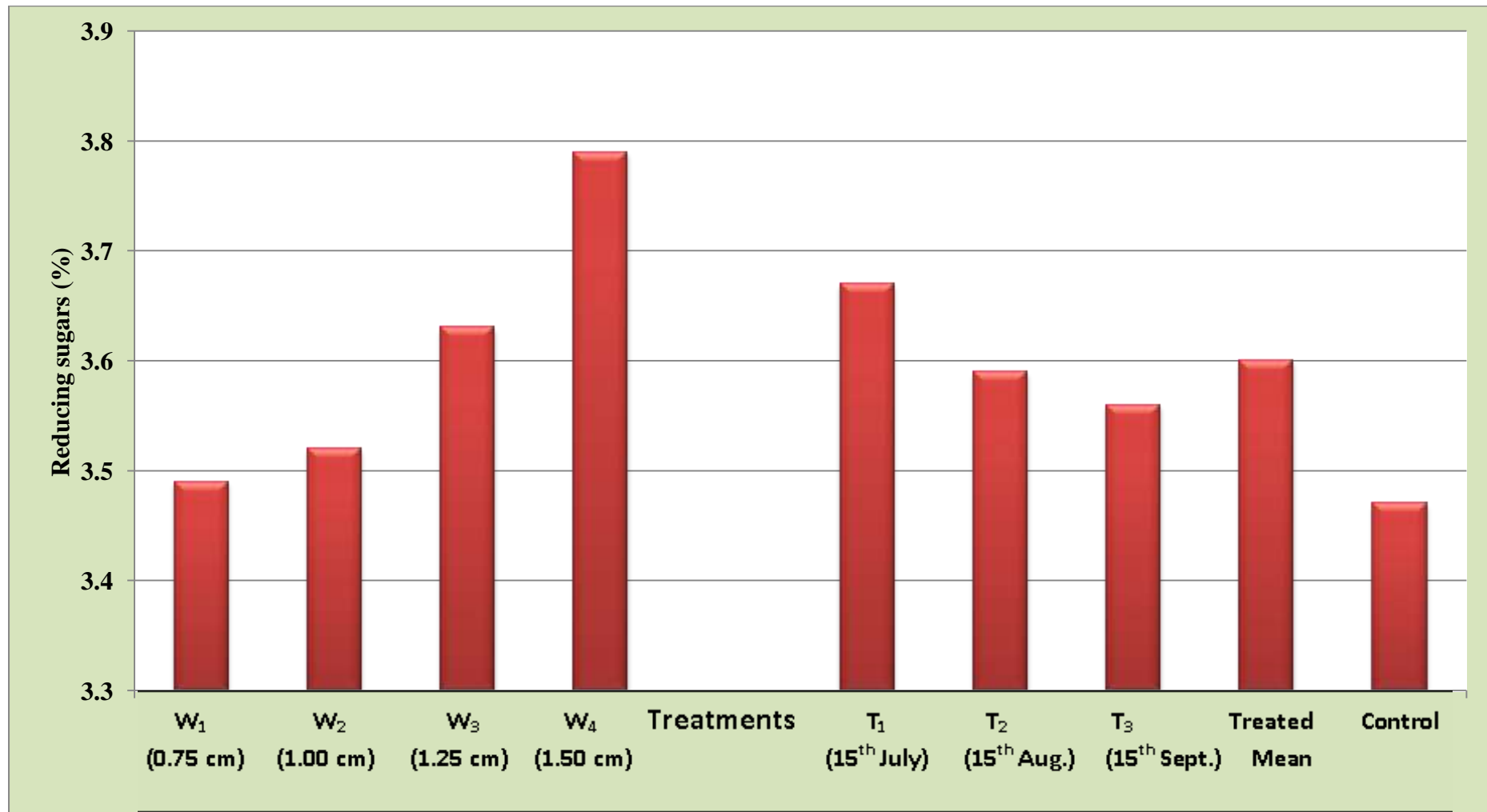
##### **4.3.4.1 Girdling width**

A persual of data presented in Table 4.18 raveled different treatments of girdling width were significantly affected the reducing sugar (%) content of the fruits. Among different girdling width, significantly maximum reducing sugars (%) of the fruit were obtained in 1.50 cm of girdling width ( $W_4$ ) treatment at both locations and in pooled analysis (3.81, 3.77 and 3.79 %, respectively) which was statistically at par with  $W_3$  treatment for both the locations. While, the minimum reducing sugar (%) were obtained in 0.75 cm girdling width ( $W_1$ ) treatment (3.49, 3.50 and 3.49 %, respectively) which were statistically at par with  $W_2$  and  $W_3$  treatments for both the locations and  $W_2$  treatment for polled analysis.

Table 4.18: Effect of time and width of girdling on reducing sugar (%) content of the fruits of mango cv. Alphonso

Treatments	Reducing sugar (%)			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	3.49	3.50	3.49	
W <sub>2</sub> – 1.00cm	3.52	3.52	3.52	
W <sub>3</sub> – 1.25cm	3.65	3.60	3.63	
W <sub>4</sub> – 1.50cm	3.81	3.77	3.79	
S.Em.±	0.06	0.07	0.05	
C.D. at 5%	0.18	0.20	0.13	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	3.69	3.66	3.67	
T <sub>2</sub> – 15 <sup>th</sup> August	3.61	3.56	3.59	
T <sub>3</sub> – 15 <sup>th</sup> September	3.55	3.56	3.56	
S.Em.±	0.05	0.06	0.04	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.11	0.12	0.08	
C.D. at 5%	NS	NS	NS	
CV%	5.22	5.62	5.41	
<b>Treated vs Control</b>				
Treated Mean	3.61	3.60	3.60	
Control	3.52	3.42	3.47	
S.Em.±	0.11	0.12	0.08	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.06	0.05	0.11	0.11
C.D. at 5%	NS	NS	NS	NS

Fig. 9: Effect of time and width of girdling on reducing sugars (%) of mango cv. Alphonso



#### **4.3.4.2. Girdling time**

The data presented in Table 4.18 revealed that different treatments of girdling time did not showed any significant effect on reducing sugars (%) at both the locations and in pooled analysis.

#### **4.3.4.3 Effect of interaction**

The interactions effect (Table 4.18) between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on total reducing sugars (%).

#### **4.3.4.4 Control vs Rest**

The data presented in Table 4.18 revealed that the control *vs.* rest of the treatments did not influenced any significant effect on reducing sugars (%) at both the locations as well as in pooled analysis.

#### **4.3.5 Total sugars (%)**

The data on total sugars (%) as affected by different treatments of girdling width and girdling time are presented in Table 4.19 and graphically depicted in Fig.10.

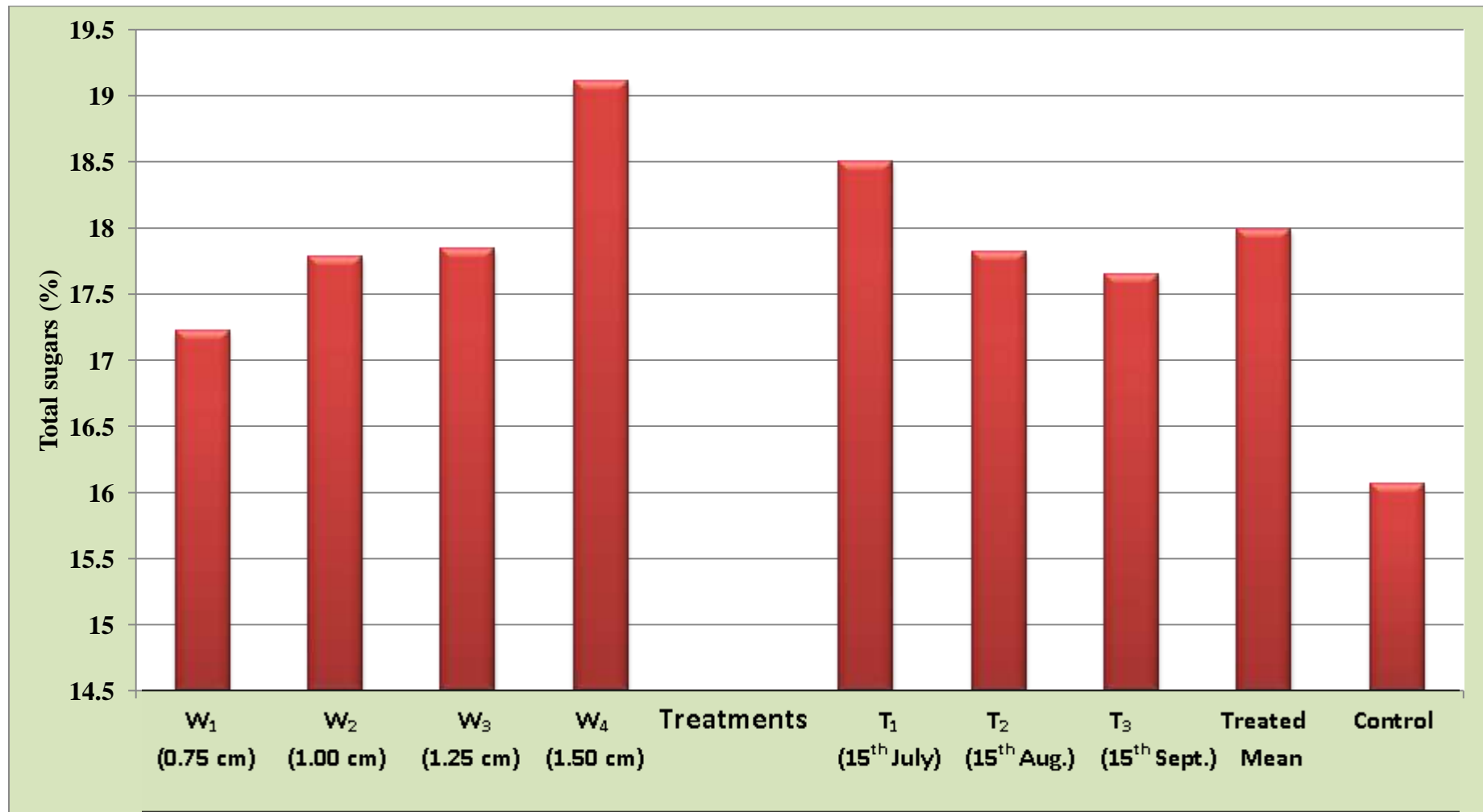
##### **4.3.5.1 Girdling width**

The data pertaining in Table 4.19 clearly indicated that total sugars (%) were significantly affected by different treatments of girdling width. Significantly maximum total sugars (%) were found in 1.50 cm girdling width ( $W_4$ ) treatment at both the locations and in pooled analysis (19.72, 18.50 and 19.11 %, respectively) which was at par with  $W_3$  treatment for Navsari location. While, minimum total sugars (%) were found in  $W_1$

**Table 4.19: Effect of time and width of girdling on total sugars (%) of mango cv. Alphonso**

Treatments		Total sugar (%)		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		17.16	17.28	17.22
W <sub>2</sub> – 1.00cm		17.80	17.67	17.78
W <sub>3</sub> – 1.25cm		18.02	17.77	17.89
W <sub>4</sub> – 1.50cm		19.72	18.50	19.11
S.Em.±		0.34	0.26	0.21
C.D. at 5%		0.99	0.75	0.61
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		18.86	18.14	18.50
T <sub>2</sub> – 15 <sup>th</sup> August		17.85	17.79	17.82
T <sub>3</sub> – 15 <sup>th</sup> September		17.81	17.49	17.65
S.Em.±		0.29	0.22	0.18
C.D. at 5%		NS	NS	NS
<b>Interaction effect (W x T)</b>				
S.Em.±		0.59	0.44	0.37
C.D. at 5%		NS	NS	NS
CV%		5.62	4.32	4.97
<b>Treated vs Control</b>				
Treated Mean		18.17	17.81	17.99
Control		16.41	15.72	16.06
S.Em.±		0.61	0.46	0.38
C.D. at 5%		1.27	0.95	0.77
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.30	0.26	0.52	0.54
C.D. at 5%	NS	NS	NS	NS

Fig. 10: Effect of time and width of girdling on total sugars (%) of mango cv. Alphonso



treatment (17.16, 17.28 and 17.22 %, respectively) which was at par with  $W_2$  and  $W_3$  treatments for Paria and Navsari locations and  $W_2$  treatment for pooled analysis.

#### **4.3.5.2 Girdling time**

The data presented in Table 4.19 revealed that total sugars had non significant effect due to different girdling time at both the locations and in pooled analysis.

#### **4.3.5.3 Effect of interaction**

The interactions effect between  $W \times T$ ,  $L \times W$ ,  $L \times T$ ,  $L \times W \times T$  and  $L \times C$  *vs*  $R$  were found non significant on total sugars (%) content of fruits at Paria, Navsari and in pooled analysis (Table 4.19).

#### **4.3.5.4 Control *vs* Rest**

The data presented in Table 4.19 revealed that control *vs* rest of the treatments were significantly affected by different treatments of girdling width and girdling time on total sugars (%). Treated treatment produced significantly maximum total sugars (%) at both the locations and in pooled analysis (18.17, 17.81 and 17.99 %, respectively).

### **4.4 Leaf tissue analysis**

The data pertaining to nutrients available in leaf with respect to nitrogen (%), phosphorous (%), potassium (%), carbohydrate contents (%) and C: N ratio as affected by different treatments of girdling width and girdling time are presented in Table 4.20 to Table 4.32.

#### **4.4.1 Nitrogen content (%)**

The nitrogen (%) in leaf tissue analysis during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January as influenced by different treatments of girdling width and different treatments of time of girdling were analysed during the experimentation and are presented in Table 4.20 to Table 4.22.

##### **4.4.1.1 Girdling width**

The data presented in Table 4.20 to Table 4.22 clearly indicated that different treatments of girdling width did not showed any significant effect on nitrogen content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January at both the locations as well as in pooled analysis.

##### **4.4.1.2 Girdling time**

A persual of data presented in Table 4.20 to Table 4.22 revealed that different treatments of girdling time were failed to exert any significant effect on nitrogen content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January at Paria and Navsari locations as well as in pooled analysis.

##### **4.4.1.1.3 Effect of interaction**

The interactions between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on nitrogen content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January (Table 4.20 to Table 4.22).

**Table 4.20: Effect of time and width of girdling on nitrogen content (%) at 15<sup>th</sup> July in mango leaves cv. Alphonso**

Treatments	Nitrogen content (%) at 15 <sup>th</sup> July			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	1.44	1.43	1.44	
W <sub>2</sub> – 1.00cm	1.47	1.48	1.47	
W <sub>3</sub> – 1.25cm	1.52	1.51	1.52	
W <sub>4</sub> – 1.50cm	1.46	1.48	1.47	
S.Em.±	0.03	0.03	0.02	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling(T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	1.49	1.47	1.48	
T <sub>2</sub> – 15 <sup>th</sup> August	1.47	1.48	1.48	
T <sub>3</sub> – 15 <sup>th</sup> September	1.46	1.48	1.47	
S.Em.±	0.03	0.03	0.02	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.05	0.05	0.04	
C.D. at 5%	NS	NS	NS	
CV%	6.25	6.00	6.13	
<b>Treated vs Control</b>				
Treated Mean	1.47	1.48	1.48	
Control	1.44	1.49	1.46	
S.Em.±	0.06	0.05	0.04	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.03	0.02	0.05	0.05
C.D. at 5%	NS	NS	NS	NS

Table 4.21: Effect of time and width of girdling on nitrogen content (%) at 15<sup>th</sup> October in mango leaves cv. Alphonso

Treatments	Nitrogen (%) content at 15 <sup>th</sup> October			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	1.40	1.41	1.41	
W <sub>2</sub> – 1.00cm	1.41	1.44	1.42	
W <sub>3</sub> – 1.25cm	1.44	1.46	1.45	
W <sub>4</sub> – 1.50cm	1.39	1.40	1.40	
S.Em.±	0.03	0.03	0.02	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	1.42	1.39	1.40	
T <sub>2</sub> – 15 <sup>th</sup> August	1.41	1.46	1.43	
T <sub>3</sub> – 15 <sup>th</sup> September	1.40	1.44	1.42	
S.Em.±	0.03	0.03	0.02	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.05	0.05	0.04	
C.D. at 5%	NS	NS	NS	
CV%	6.33	6.16	6.29	
<b>Treated vs Control</b>				
Treated Mean	1.41	1.43	1.42	
Control	1.37	1.40	1.39	
S.Em.±	0.05	0.05	0.04	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.29	0.25	0.51	0.53
C.D. at 5%	NS	NS	NS	NS

Table 4.22: Effect of time and width of girdling on nitrogen content (%) at 15<sup>th</sup> January in mango leaves cv. Alphonso

Treatments	Nitrogen (%) content at 15 <sup>th</sup> January			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	1.30	1.28	1.29	
W <sub>2</sub> – 1.00cm	1.33	1.33	1.33	
W <sub>3</sub> – 1.25cm	1.35	1.37	1.36	
W <sub>4</sub> – 1.50cm	1.31	1.32	1.32	
S.Em.±	0.02	0.03	0.02	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	1.33	1.30	1.31	
T <sub>2</sub> – 15 <sup>th</sup> August	1.33	1.34	1.33	
T <sub>3</sub> – 15 <sup>th</sup> September	1.31	1.34	1.32	
S.Em.±	0.02	0.03	0.02	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.04	0.06	0.03	
C.D. at 5%	NS	NS	NS	
CV%	5.55	7.22	6.45	
<b>Treated vs Control</b>				
Treated Mean	1.32	1.32	1.32	
Control	1.29	1.34	1.32	
S.Em.±	0.04	0.06	0.04	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.28	0.24	0.49	0.51
C.D. at 5%	NS	NS	NS	NS

#### **4.4.1.1.4 Control vs Rest**

The data presented in Table 4.20 to Table 4.22 revealed that the control *vs* rest of the treatment analysis did not showed any significant effect on nitrogen content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January at both the locations as well as in pooled analysis.

#### **4.4.2 Phosphorus content (%)**

For phosphorous content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January as influenced by different girdling widths and different times of girdling were recorded during the experimentation and are presented in Table 4.23 to Table 4.25.

##### **4.4.2.1. Girdling width**

A persual of data presented in Table 4.23 to Table 4.25 revealed that different treatments of girdling width did not showed any significant effect on phosphorus content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January at both the locations as well as pooled analysis.

##### **4.4.2.2 Girdling time**

The data presented in Table 4.23 to Table 4.25 clearly indicated that the different treatments of girdling time failed to exert any significant effect on phosphorus content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January at both the locations as well as in pooled.

Table 4.23: Effect of time and width of girdling on phosphorous content (%) at 15<sup>th</sup> July in mango leaves cv. Alphonso

Treatments	Phosphorous content (%) at 15 <sup>th</sup> July			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	0.176	0.170	0.173	
W <sub>2</sub> – 1.00cm	0.166	0.166	0.166	
W <sub>3</sub> – 1.25cm	0.167	0.165	0.166	
W <sub>4</sub> – 1.50cm	0.165	0.160	0.163	
S.Em.±	0.004	0.004	0.003	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	0.168	0.169	0.168	
T <sub>2</sub> – 15 <sup>th</sup> August	0.170	0.163	0.166	
T <sub>3</sub> – 15 <sup>th</sup> September	0.162	0.165	0.164	
S.Em.±	0.004	0.003	0.002	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.007	0.006	0.005	
C.D. at 5%	NS	NS	NS	
CV%	7.75	6.75	7.24	
<b>Treated vs Control</b>				
Treated Mean	0.167	0.165	0.166	
Control	0.173	0.167	0.170	
S.Em.±	0.008	0.007	0.005	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.004	0.003	0.006	0.007
C.D. at 5%	NS	NS	NS	NS

Table 4.24: Effect of time and width of girdling on phosphorous content (%) at 15<sup>th</sup> October in mango leaves cv. Alphonso

Treatments	Phosphorous content (%) at 15 <sup>th</sup> October			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	0.169	0.164	0.166	
W <sub>2</sub> – 1.00cm	0.164	0.163	0.164	
W <sub>3</sub> – 1.25cm	0.162	0.168	0.165	
W <sub>4</sub> – 1.50cm	0.159	0.154	0.157	
S.Em.±	0.004	0.004	0.003	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	0.166	0.166	0.166	
T <sub>2</sub> – 15 <sup>th</sup> August	0.165	0.161	0.163	
T <sub>3</sub> – 15 <sup>th</sup> September	0.159	0.161	0.160	
S.Em.±	0.004	0.004	0.003	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.007	0.007	0.005	
C.D. at 5%	NS	NS	NS	
CV%	7.47	7.75	7.58	
<b>Treated vs Control</b>				
Treated Mean	0.163	0.162	0.163	
Control	0.173	0.165	0.169	
S.Em.±	0.007	0.008	0.005	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.004	0.003	0.007	0.007
C.D. at 5%	NS	NS	NS	NS

Table 4.25: Effect of time and width of girdling on phosphorous content (%) at 15<sup>th</sup> January in mango leaves cv. Alphonso

Treatments	Phosphorous content (%) at 15 <sup>th</sup> January			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	0.166	0.162	0.164	
W <sub>2</sub> – 1.00cm	0.155	0.159	0.157	
W <sub>3</sub> – 1.25cm	0.158	0.154	0.156	
W <sub>4</sub> – 1.50cm	0.155	0.152	0.154	
S.Em.±	0.004	0.003	0.003	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	0.159	0.161	0.160	
T <sub>2</sub> – 15 <sup>th</sup> August	0.161	0.152	0.157	
T <sub>3</sub> – 15 <sup>th</sup> September	0.155	0.157	0.156	
S.Em.±	0.004	0.003	0.002	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.007	0.006	0.005	
C.D. at 5%	NS	NS	NS	
CV%	7.91	6.33	7.14	
<b>Treated vs Control</b>				
Treated Mean	0.158	0.157	0.158	
Control	0.161	0.160	0.161	
S.Em.±	0.008	0.006	0.005	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.003	0.003	0.006	0.006
C.D. at 5%	NS	NS	NS	NS

#### **4.4.2.3 Effect of interaction**

The interactions effect between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on phosphorus content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January (Table 4.23 to Table 4.25).

#### **4.4.2.4 Control *vs* Rest**

The data presented in Table 4.23 to Table 4.25 indicated that control *vs* rest of the treatments did not showed any significant effect on phosphorus content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January by different girdling widths and girdling times at both the locations and in pooled analysis.

#### **4.4.3 Potassium content (%)**

For potassium content (%) in leaf tissue analysis during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January as influenced by different girdling width and different time of girdling were recorded during the experimentation and are presented in Table 4.26 to Table 4.28.

##### **4.4.3.1. Girdling width**

It is apparent from the data (Table 4.26 to Table 4.28) that different treatments of girdling width did not showed any significant effect on potassium content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January at both the locations as well as pooled analysis.

Table 4.26: Effect of time and width of girdling on potassium content (%) at 15<sup>th</sup> July in mango leaves cv. Alphonso

Treatments	Potassium content (%) at 15 <sup>th</sup> July			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75 cm	0.818	0.808	0.813	
W <sub>2</sub> – 1.00 cm	0.817	0.826	0.821	
W <sub>3</sub> – 1.25 cm	0.807	0.817	0.812	
W <sub>4</sub> – 1.50 cm	0.813	0.811	0.812	
S.Em.±	0.017	0.017	0.012	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	0.816	0.817	0.817	
T <sub>2</sub> – 15 <sup>th</sup> August	0.808	0.813	0.810	
T <sub>3</sub> – 15 <sup>th</sup> September	0.813	0.817	0.815	
S.Em.±	0.015	0.015	0.011	
C.D. at 5%	NS	NS	NS	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.031	0.031	0.022	
C.D. at 5%	NS	NS	NS	
CV%	6.70	6.57	6.65	
<b>Treated vs Control</b>				
Treated Mean	0.814	0.816	0.815	
Control	0.818	0.803	0.811	
S.Em.±	0.031	0.030	0.021	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.017	0.015	0.030	0.031
C.D. at 5%	NS	NS	NS	NS

Table 4.27: Effect of time and width of girdling on potassium content (%) at 15<sup>th</sup> October in mango leaves cv. Alphonso

Treatments		Potassium content (%) at 15 <sup>th</sup> October		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		0.811	0.801	0.806
W <sub>2</sub> – 1.00cm		0.816	0.823	0.819
W <sub>3</sub> – 1.25cm		0.807	0.816	0.811
W <sub>4</sub> – 1.50cm		0.812	0.806	0.809
S.Em.±		0.018	0.017	0.012
C.D. at 5%		NS	NS	NS
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		0.815	0.812	0.814
T <sub>2</sub> – 15 <sup>th</sup> August		0.806	0.807	0.807
T <sub>3</sub> – 15 <sup>th</sup> September		0.812	0.815	0.814
S.Em.±		0.015	0.014	0.011
C.D. at 5%		NS	NS	NS
<b>Interaction effect (W x T)</b>				
S.Em.±		0.031	0.029	0.021
C.D. at 5%		NS	NS	NS
CV%		6.54	6.18	6.36
<b>Treated vs Control</b>				
Treated Mean		0.811	0.812	0.811
Control		0.814	0.794	0.804
S.Em.±		0.032	0.030	0.022
C.D. at 5%		NS	NS	NS
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.017	0.014	0.029	0.031
C.D. at 5%	NS	NS	NS	NS

Table 4.28: Effect of time and width of girdling on potassium content (%) at 15<sup>th</sup> January in mango leaves cv. Alphonso

Treatments		Potassium content (%) at 15 <sup>th</sup> January		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		0.806	0.797	0.802
W <sub>2</sub> – 1.00cm		0.811	0.819	0.815
W <sub>3</sub> – 1.25cm		0.802	0.811	0.807
W <sub>4</sub> – 1.50cm		0.807	0.802	0.805
S.Em.±		0.018	0.017	0.012
C.D. at 5%		NS	NS	NS
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		0.811	0.808	0.809
T <sub>2</sub> – 15 <sup>th</sup> August		0.802	0.803	0.803
T <sub>3</sub> – 15 <sup>th</sup> September		0.808	0.811	0.809
S.Em.±		0.015	0.014	0.011
C.D. at 5%		NS	NS	NS
<b>Interaction effect (W x T)</b>				
S.Em.±		0.031	0.029	0.021
C.D. at 5%		NS	NS	NS
CV%		6.57	6.22	6.40
<b>Treated vs Control</b>				
Treated Mean		0.807	0.807	0.807
Control		0.809	0.790	0.800
S.Em.±		0.032	0.030	0.022
C.D. at 5%		NS	NS	NS
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.017	0.014	0.029	0.030
C.D. at 5%	NS	NS	NS	NS

#### **4.4.3.2 Girdling time**

A perusal of data presented in Table 4.26 to Table 4.28 revealed that different treatments of girdling time failed to exert any significant effect on potassium content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January at both the locations as well as in pooled analysis.

#### **4.4.3.3 Effect of interaction**

The interactions effect between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant on potassium content (%) in leaf tissue analysis during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January (Table 4.26 to Table 4.28).

#### **4.4.3.4 Control *vs* Rest**

The data presented in Table 4.26 to Table 4.28 indicated that the control *vs* rest of the treatments resulted non significant effect on potassium content (%) in leaf tissue analysis during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January at both the locations as well as in pooled analysis.

#### **4.3.3 Carbohydrate content (%)**

For carbohydrate content (%) in leaf tissue analysis during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January influenced by different girdling width and different girdling time were recorded during the experimentation and are presented in Table 4.29 to Table 4.31 and graphically depicted in Fig.11 to Fig.12.

##### **4.4.4.1. Girdling width**

A perusal of data presented in Table 4.29 and Table 4.30 clearly indicated that different treatments of girdling width did not showed any significant effect on carbohydrate content

(%) during 15<sup>th</sup> July and 15<sup>th</sup> October at both the locations as well as pooled analysis but in case of carbohydrate content (%) during 15<sup>th</sup> January (Table 4.31) it was found significant effect with different girdling widths. Significantly the maximum carbohydrate content (%) in leaf tissue during 15<sup>th</sup> January was obtained in 1.50 cm of girdling width ( $W_4$ ) treatment at both the locations and in pooled analysis (16.62, 16.59 and 16.60 %, respectively) which was statistically at par with  $W_3$  and  $W_2$  treatments for Paria and Navsari locations and  $W_3$  in pooled analysis. While, minimum carbohydrate content (%) in leaf tissue during 15<sup>th</sup> January was found in  $W_1$  treatment (15.34, 15.18 and 15.26 %, respectively) which was at par with  $W_2$  and  $W_3$  treatments for both the locations.

#### **4.4.4.2 Girdling time**

The data indicated in Table 4.29 revealed that different treatments of girdling time failed to exert any significant effect on carbohydrate content (%) in leaves during 15<sup>th</sup> July for both the locations and in pooled analysis. But carbohydrate content (%) during 15<sup>th</sup> October and 15<sup>th</sup> January were found significant effect with different treatments of girdling times. Among different girdling time (Table 4.30), significantly maximum carbohydrate content (%) in leaf tissue during 15<sup>th</sup> October was revealed in 15<sup>th</sup> July girdling ( $T_1$ ) at both the locations and in pooled analysis (14.26, 13.99 and 14.13 %, respectively). While, the minimum carbohydrate content (%) in leaf tissue was obtained during 15<sup>th</sup> August ( $T_2$ ) treatment (13.12, 12.94 and 13.30 %, respectively) which was statistically at par with  $T_2$  treatment for both the locations as well as in pooled analysis. In case of carbohydrate content (%) in 15<sup>th</sup>

January (Table 4.31) which was significantly affected by varying girdling time. Among different girdling time, girdling during 15<sup>th</sup> July (T<sub>1</sub>) produced significantly maximum carbohydrate content (%) in leaf tissue during 15<sup>th</sup> January at both the locations and in pooled (16.99, 16.69 and 16.84 %, respectively). While, the minimum carbohydrate content (%) during 15<sup>th</sup> January was obtained in T<sub>3</sub> treatment (15.45, 15.41 and 15.43 %, respectively) which was statistically at par with T<sub>2</sub> treatment for both the locations as well as in pooled analysis.

#### **4.4.4.3 Effect of interaction**

The interactions between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant effect on carbohydrate content (%) in leaf tissue during 15<sup>th</sup> July, 15<sup>th</sup> October and 15<sup>th</sup> January (Table 4.29 Table 4.31).

#### **4.4.4.4 Control vs Rest**

The data presented in Table 4.29 to Table 4.30 revealed that control *vs* rest of the treatments did not influenced any significant effect on carbohydrate content (%) in leaf tissue analysis during 15<sup>th</sup> July and 15<sup>th</sup> October at both the locations as well as in pooled analysis. But it was found significant on carbohydrate content (%) in leaf tissue during 15<sup>th</sup> January at Paria and Navsari locations and in pooled analysis (Table 4.30). Significantly higher percentages of carbohydrates content were found in leaves of treated plants (16.02, 15.91 and 15.96 %, respectively).

Table 4.29: Effect of time and width of girdling on carbohydrate content (%) at 15<sup>th</sup> July in mango leaves cv. Alphonso

Treatments		Carbohydrate content (%) at 15 <sup>th</sup> July		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
<b>W<sub>1</sub> – 0.75cm</b>		12.467	12.368	12.417
<b>W<sub>2</sub> – 1.00cm</b>		12.694	12.716	12.705
<b>W<sub>3</sub> – 1.25cm</b>		12.867	12.622	12.745
<b>W<sub>4</sub> – 1.50cm</b>		12.556	12.847	12.701
<b>S.Em.±</b>		0.293	0.315	0.215
<b>C.D. at 5%</b>		NS	NS	NS
<b>Time of Girdling (T)</b>				
<b>T<sub>1</sub> – 15<sup>th</sup> July</b>		12.733	13.078	12.906
<b>T<sub>2</sub> – 15<sup>th</sup> August</b>		12.583	12.095	12.339
<b>T<sub>3</sub> – 15<sup>th</sup> September</b>		12.621	12.742	12.681
<b>S.Em.±</b>		0.254	0.273	0.187
<b>C.D. at 5%</b>		NS	NS	NS
<b>Interaction effect (W x T)</b>				
<b>S.Em.±</b>		0.508	0.546	0.373
<b>C.D. at 5%</b>		NS	NS	NS
<b>CV%</b>		6.96	7.48	7.23
<b>Treated vs Control</b>				
<b>Treated Mean</b>		12.646	12.638	12.642
<b>Control</b>		12.667	12.703	12.685
<b>S.Em.±</b>		0.529	0.568	0.388
<b>C.D. at 5%</b>		NS	NS	NS
<b>Pooled interaction</b>				
<b>Source</b>	<b>L x W</b>	<b>L x T</b>	<b>L x W x T</b>	<b>Lx (Treated Vs Control)</b>
<b>S.Em.±</b>	0.30	0.26	0.52	0.54
<b>C.D. at 5%</b>	NS	NS	NS	NS

Table 4.30: Effect of time and width of girdling on carbohydrate content (%) at 15<sup>th</sup> October in mango leaves cv. Alphonso

Treatments		Carbohydrate content (%) at 15 <sup>th</sup> October		
		Paria	Navsari	Pooled
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm		13.38	13.12	13.25
W <sub>2</sub> – 1.00cm		13.45	13.34	13.40
W <sub>3</sub> – 1.25cm		13.60	13.54	13.57
W <sub>4</sub> – 1.50cm		13.89	13.57	13.73
S.Em.±		0.30	0.29	0.21
C.D. at 5%		NS	NS	NS
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		14.26	13.99	14.13
T <sub>2</sub> – 15 <sup>th</sup> August		13.12	12.94	13.03
T <sub>3</sub> – 15 <sup>th</sup> September		13.36	13.24	13.30
S.Em.±		0.26	0.25	0.18
C.D. at 5%		0.77	0.74	0.52
<b>Interaction effect (W x T)</b>				
S.Em.±		0.531	0.509	0.368
C.D. at 5%		NS	NS	NS
CV%		6.77	6.58	6.72
<b>Treated vs Control</b>				
Treated Mean		13.397	13.585	13.491
Control		13.173	13.420	13.297
S.Em.±		0.55	0.52	0.38
C.D. at 5%		NS	NS	NS
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.30	0.25	0.51	0.54
C.D. at 5%	NS	NS	NS	NS

Fig. 11: Effect of time and width of girdling on carbohydrate content (%) at 15<sup>th</sup> October in mango leaves cv. Alphonso

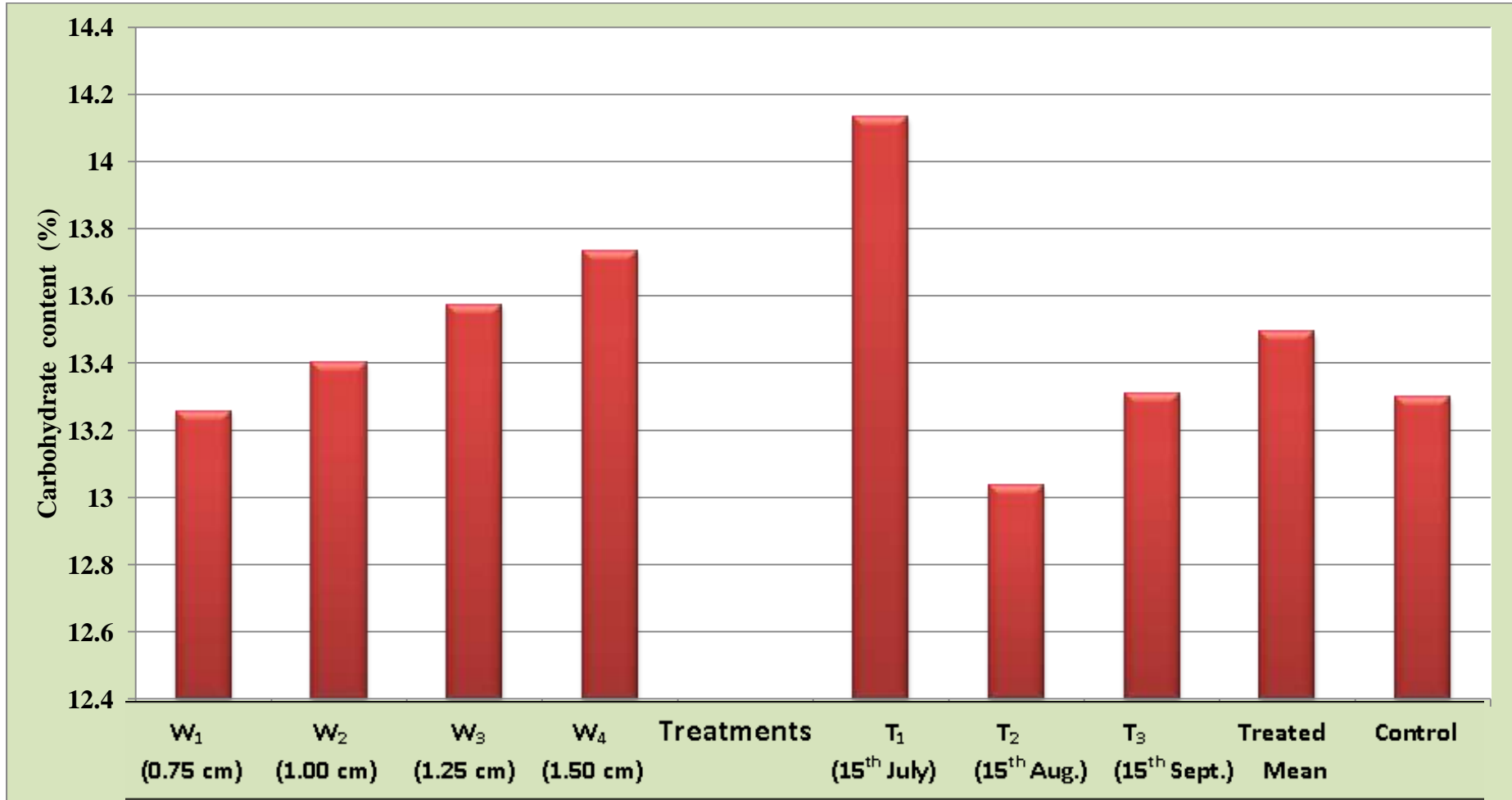
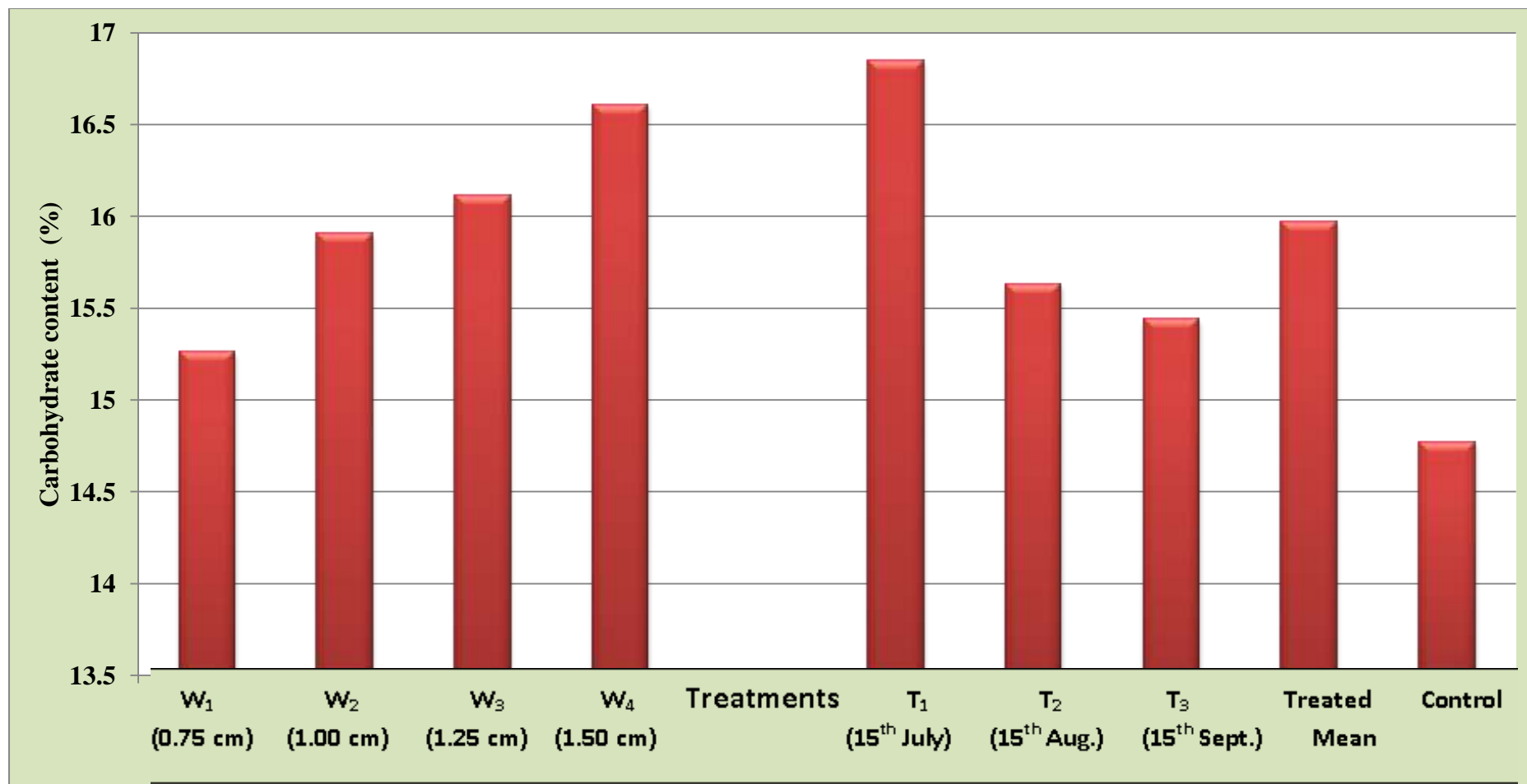


Table 4.31: Effect of time and width of girdling on carbohydrate content (%) at 15<sup>th</sup> January in mango leaves cv. Alphonso

Treatments		Carbohydrate content (%) at 15 <sup>th</sup> January		
		Paria	Navsari	Pooled
<b>Width of Girdling(W)</b>				
W <sub>1</sub> – 0.75cm		15.34	15.18	15.26
W <sub>2</sub> – 1.00cm		15.95	15.84	15.90
W <sub>3</sub> – 1.25cm		16.18	16.04	16.11
W <sub>4</sub> – 1.50cm		16.62	16.59	16.60
S.Em.±		0.29	0.31	0.21
C.D. at 5%		0.84	0.92	0.61
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July		16.99	16.69	16.84
T <sub>2</sub> – 15 <sup>th</sup> August		15.62	15.63	15.62
T <sub>3</sub> – 15 <sup>th</sup> September		15.45	15.41	15.43
S.Em.±		0.25	0.27	0.18
C.D. at 5%		0.73	0.80	0.53
<b>Interaction effect (W x T)</b>				
S.Em.±		0.50	0.55	0.37
C.D. at 5%		NS	NS	NS
CV%		5.43	6.00	5.74
<b>Treated vs Control</b>				
Treated Mean		16.02	15.91	15.96
Control		14.83	14.70	14.77
S.Em.±		0.52	0.57	0.38
C.D. at 5%		1.07	1.18	0.78
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.30	0.26	0.53	0.55
C.D. at 5%	NS	NS	NS	NS

Fig. 12: Effect of time and width of girdling on carbohydrate content (%) at 15<sup>th</sup> January in mango leaves cv. Alphonso





**Plate 6: Effect of girdling on carbohydrate accumulation above the girdled portion of mango cv. Alphonso at Paria.**



**Plate 7: Effect of girdling on carbohydrate accumulation above the girdled portion of mango cv. Alphonso at Navsari.**

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#### **4.4.5 C: N ratio in leaves**

The data on C: N ratio in leaves as affected by different treatments of girdling time and girdling width are presented in Table 4.32 and graphically illustrated in Fig. 13.

##### **4.4.5.1 Girdling width**

A perusal of data presented in Table 4.32 revealed that different treatments of girdling width did not influenced any significant effect on C: N ratio in leaves at both the locations as well as in pooled analysis.

##### **4.4.5.2 Girdling time**

The data presented in Table 4.32 revealed that different treatments of girdling time were significantly affected on C: N ratio. Among the different girdling time, significantly maximum C: N ratio in leaves were obtained in 15<sup>th</sup> July (T<sub>1</sub>) treatment at both the locations as well as in pooled analysis (13.20, 12.59 and 12.89 %, respectively). While, the minimum C: N ratio in leaves were obtained in T<sub>3</sub> treatment (11.57, 11.77 and 11.67 %, respectively) which was statistically at par with T<sub>2</sub> treatment for both the locations as well as in pooled analysis.

##### **4.4.5.3 Effect of interaction**

The interactions between W x T, L x W, L x T, L x W x T and L x C *vs* R were found non significant effect on C: N ratio (Table 4.32).

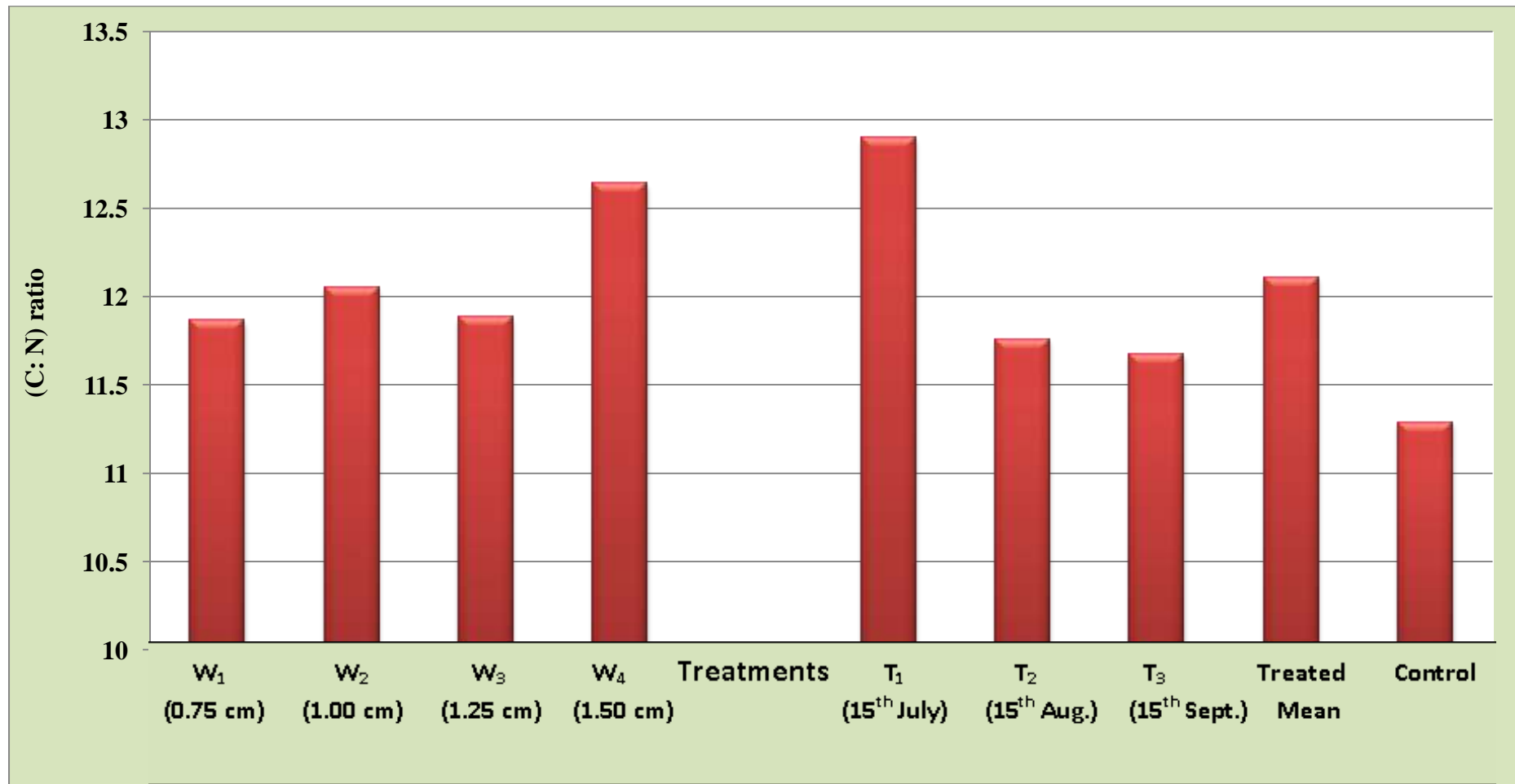
##### **4.4.5.4 Control *vs* Rest**

The data presented in Table 4.32 revealed that control *vs* rest of the treatments analysis were found non significant effect on C: N ratio in leaf tissue at Paria and Navsari locations and in pooled analysis.

Table 4.32: Effect of time and width of girdling on C: N ratio at 15<sup>th</sup> January in mango leaves cv. Alphonso

Treatments	C: N ratio at 15 <sup>th</sup> January			
	Paria	Navsari	Pooled	
<b>Width of Girdling (W)</b>				
W <sub>1</sub> – 0.75cm	12.07	11.65	11.86	
W <sub>2</sub> – 1.00cm	12.13	11.97	12.05	
W <sub>3</sub> – 1.25cm	11.84	11.91	11.88	
W <sub>4</sub> – 1.50cm	12.59	12.69	12.64	
S.Em.±	0.39	0.27	0.24	
C.D. at 5%	NS	NS	NS	
<b>Time of Girdling (T)</b>				
T <sub>1</sub> – 15 <sup>th</sup> July	13.20	12.59	12.89	
T <sub>2</sub> – 15 <sup>th</sup> August	11.70	11.81	11.75	
T <sub>3</sub> – 15 <sup>th</sup> September	11.57	11.77	11.67	
S.Em.±	0.34	0.24	0.20	
C.D. at 5%	0.99	0.70	0.59	
<b>Interaction effect (W x T)</b>				
S.Em.±	0.68	0.48	0.41	
C.D. at 5%	NS	NS	NS	
CV%	9.72	6.89	8.47	
<b>Treated vs Control</b>				
Treated Mean	12.16	12.05	12.11	
Control	11.08	11.49	11.28	
S.Em.±	0.711	0.49	0.43	
C.D. at 5%	NS	NS	NS	
<b>Pooled interaction</b>				
Source	L x W	L x T	L x W x T	Lx (Treated Vs Control)
S.Em.±	0.34	0.29	0.58	0.61
C.D. at 5%	NS	NS	NS	NS

Fig. 13: Effect of time and width of girdling on C: N ratio at 15<sup>th</sup> January in mango leaves cv. Alphonso



#### 4.5 Economics

The data pertaining to the effect of different treatments of girdling width and girdling time on economics are presented in Table 4.33.

##### 4.5.1. Girdling width

The data presented in Table 4.33 clearly indicated that different girdling widths were found effective on net realization and B: C ratio. Maximum net realization (2, 34,883 Rs/ha) and B: C ratio (4.09) were obtained in 1.50 cm of girdling width ( $W_4$ ) treatment. While, minimum net realization (1, 89, 436 Rs/ha) and B: C ratio (3.39) were noted in 0.75 cm of girdling width ( $W_1$ ) treatment.

##### 4.5.2. Girdling time

A persual of data presented in Table 4.33 revealed that varying girdling time were affected on net realization and B: C ratio. Among different girdling time, girdling in 15<sup>th</sup> July ( $T_1$ ) treatment produced maximum net realization (2, 25,545 Rs/ha) and B: C ratio (3.95). While, the minimum net realization (1, 88, 906 Rs/ha) and B: C ratio (3.39) were obtained in girdling in 15<sup>th</sup> September ( $T_3$ ) treatment.

##### 4.5.3. Control vs rest

It is evident from the data (Table 4.33) that control vs rest of the treatment analysis on net realization and B: C ratio. Maximum net realization (2, 07, 252 Rs/ha) and B: C ratio (3.67) were obtained in treated treatment as compared to control (1, 62, 552 Rs/ha and 3.06, respectively).

**Table 4. 33: Effect of different treatments of girdling time and girdling widths on economics of mango cv. Alphonso**

Treatments	Fruit Yield (Kg/ha)	Treatment Cost (Rs./ha)	Harvesting Cost (Rs./ha)	Fixed Cost (Rs./ha)	Cost of Cultivation (Rs./ha)	Gross Return (Rs./ha)	Net Realization (Rs./ha)	BCR
<b>Width of girdling (W)</b>								
<b>W<sub>1</sub></b>	8175	1700	8175	45940	55815	245251	189436	3.39
<b>W<sub>2</sub></b>	8437	1700	8437	45940	56077	253099	197022	3.51
<b>W<sub>3</sub></b>	8804	1700	8804	45940	56444	264109	207666	3.68
<b>W<sub>4</sub></b>	9742	1700	9742	45940	57382	292266	234883	4.09
<b>Time of girdling (T)</b>								
<b>T<sub>1</sub></b>	9420	1700	9420	45940	57060	282605	225545	3.95
<b>T<sub>2</sub></b>	8791	1700	8791	45940	56431	263736	207305	3.67
<b>T<sub>3</sub></b>	8157	1700	8157	45940	55797	244703	188906	3.39
<b>Treated vs Control</b>								
<b>Treated</b>	8789	1700	8789	45940	56429	263681	207252	3.67
<b>Control</b>	7189	0	7189	45940	53129	215682	162552	3.06

Cost of Copper oxychloride: Rs. 500/kg

Labour cost: Rs. 1200

Other expenditure: Cost of insecticide, pesticide, Irrigation, Cost of paclobutrazol (Rs. 4500/lit.)

Retail Price of Alphonso mango fruits: Rs. 30/Kg



# DISCUSSION

## **CHAPTER - V**

### **DISCUSSION**



The investigations were carried out at Agriculture Experimental Station, Paria, Navsari Agricultural University, Paria, Dist. Valsad and at Regional Horticultural Research Station, Navsari Agricultural University, Navsari, entitled “Effect of time and width of girdling on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Alphonso” by the application of different width and girdling time as well as in combination. In this chapter, it is contemplated to discuss the variations observed in flowering parameters with respect to days required for flowering, length of flowering panicles, sex ratio, fruit set percentage, fruit drop percentage and days required for fruit maturity while, fruiting parameters with respect to fruit weight (g) volume of pulp (ml), number of fruits per shoots, yield kg per plant, estimated yield tons per hectare, quality parameters like, TSS, acidity, ascorbic acid, reducing sugars and total sugars of fruit and leaf nutrient analysis with respect to nitrogen (%), phosphorous (%), potassium (%) and carbohydrate content (%) and C: N ratio. It has been attempted to establish ‘effect and cause relationship’ based on the results of the present investigation duly supported by appropriate reasoning with available evidences of the earlier research workers.

The entire discussion has been divided into following sub-heads:

- 5.1 Effect on flowering parameters**
- 5.2 Effect on fruiting parameters**
- 5.3 Effect on quality parameters**
- 5.4 Effect on leaf tissue analysis**

The discussion in details has been given in following:

### 5.1. Effect on flowering parameters

Different treatments of girdling width and girdling time were failed to exert any significant effects on various flowering parameters *viz.*, day required for flowering, length of flowering shoots, sex ratio, fruit drop percentage and days taken from to pea stage to maturity. While, it was significant on percentages of fruit set at harvest stage.

Different girdling widths were reacted in a different way to the flowering parameters. Among the different girdling widths, maximum percentage of fruit set at harvest stage was significantly influenced in 1.50 cm girdling width ( $W_4$ ) treatment and minimum percentage of fruit set noticed in 0.75 cm girdling width ( $W_1$ ) treatment. This might be due to the phloem stress by girdling on the branch. Actually girdling block the transport of sugars to the roots, large amount of carbohydrates produced by photosynthesis will accumulate in vegetative organs above the girdling, the enhancement of carbohydrate availability has been associated with an improvement fruit which leads to increase fruit set percentage (Gaskins, 1963 and Oothuyse, 1990). The similar confiding were found by Goren *et al.*, (2003) in citrus; Lahav *et al.* (1986) in avocado; Hossain and Boyce (2009) in fig; Reddy and Prakash (1989) in grape; Khalil *et al.* (2012) in olive; Cotrut and Stanica (2015) in ber; Khandekar *et al.* (2011) in jamun; Tuan *et al.* (2012) in apple and Fayek *et al.* (2011) in pear.

Among different treatments of girdling time, 15<sup>th</sup> July girdling time ( $T_1$ ) gave significantly maximum fruit set (%) and minimum fruit set (%) observed in 15<sup>th</sup> September girdling time ( $T_3$ ). This might be due to the environmental conditions and 15<sup>th</sup>

July treatment is one and two month before than other treatments. Early girdling increased carbohydrates continuously as compare to later girdling. So this might be the main reason for accumulation of carbohydrate which was more in 15<sup>th</sup> July girdled than both times and after July treatment. This higher content of accumulated carbohydrate help to increased in fruit set percentage. Similar trends were observed by Chun *et al.* (1996) in citrus.

In case of control *vs* rest of the treatment fruit set (%) was significantly perform better in all girdled treatment than the control (un-girdled treatment). This is might be due to the phloem stress by girdling. Girdling blocked the transport of sugars to the roots, large amount of carbohydrates produced by photosynthesis will accumulate in vegetative organs above the girdling which leads to increased fruit set percentage. The similar confiding were found by Goren *et al.*, (2003) in citrus and Gaskins (1963) and Oothuyse (1990) in mango.

All the interactions between girdling width and different treatments of girdling time were found non-significant in all the flowering parameters.

## 5.2 Effect on fruiting parameters

Different treatments of girdling width and girdling times were non significantly affected the fruiting parameters *viz.*, stone weight, peel weight, pulp: peel: stone ratio. While it was significant on fruit weight (g), volume of pulp (ml), number of fruits per shoot, yield kg per plant and fruit yield tons per hectare.

Among the different girdling width, maximum fruit weight (g) and volume of pulp (ml) were found in 1.50 cm girdling width ( $W_4$ ) treatment and while, minimum fruit weight (g) and volume of pulp (ml) were recorded in 0.75 cm girdling width ( $W_1$ ) treatment. This might be due to the girdling severes phloem vascular vessels thereby preventing translocation of photosynthates from the source to sinks located below the girdled until the wound heals. Thus, girdling has an indirect effect of reducing sink size and increasing the amount of photosynthates available to fruits and other active meristems above the girdled region and which lead in improvement of fruit weight and volume of pulp (Poll-van Der *et al*, 1991). The similar trends were found by Tuan *et al*. (2012) in apple; Goldschmidt *et al*, (1999) and Goren *et al*, (2003) in citrus and Braconi (1969) in olive. Nearer to similar findings were also reported by Reddy and Prakash (1989) and Desouza *et al*. (2010) in grape; Rani and Brahmachari (2002) in litchi and Ahmed *et al*. (2009) in olive.

The data pertaining to the number of fruits per shoot, yield kg per plant and yield tons per hectare were significantly influenced by different treatments of girdling width. Significantly highest number of fruits per shoot, yield kg per plant and yield tons per hectare were significantly influenced in 1.50 cm girdling width ( $W_4$ ) treatment and while, minimum conformed in 0.75 cm girdling width ( $W_1$ ) treatment. It is might be due to girdling can improved carbohydrate availability to fruits and as a consequent lead to an increased fruit set percentage with decreased bud drop due to branch girdling and also which leads to increased maximum number of fruit per shoots and maximum fruit weight which help to increased fruit yield kg per plant and fruit yield kg per hectare

in same treatment (Goren *et al.*, 2003). Thus, our results could be in agreement with the findings of Lahav *et al.* (1970) and Lahav *et al.* (1972) in avocado; Greenberg (2004) in citrus; Ahmad and Zargar (2005) in grape; Hossain and Boyce (2009) in fig; Khandekar *et al.* (2012) apple and Rakshe *et al.* (2013) and Shinde *et al.* (2014) in mango.

Different girdling time was responded differently to the fruiting parameters. Among the different girdling time, fruit weight (g) and pulp volume (ml), showed significantly maximum in 15<sup>th</sup> July of girdling time (T<sub>1</sub>) treatment as compare to 15<sup>th</sup> August (T<sub>2</sub>) and 15<sup>th</sup> September (T<sub>3</sub>) treatments. The increased in carbohydrate level in the leaves increased in fruit retention and girdling application ascribed to increased level of carbohydrates. Carbohydrate availability to fruits and as a consequent lead to an increased fruit set percentages with decreased bud drop due to branch girdling. Nearer to same finding also discovered by with Rakshe *et al.* (2014) in mango, Giacobbo *et al.* (2012) in citrus; Khandekar *et al.* (2011) in jamun, Tuan *et al.* (2012) and Khandekar *et al.* (2012) in apple; Fayek *et al.* (2011) in pear and Day and DeJong (1990) and Hossain *et al.* (2006) in peach.

Number of fruits per shoot, fruit yield kg per plant and fruit yield tons per hectare were significantly influenced by 15<sup>th</sup> July girdling time (T<sub>1</sub>) treatment which was superior over other girdling time. This might be due to the 15<sup>th</sup> July girdling time (T<sub>1</sub>) treatment in which accumulation of carbohydrate was higher than other treatments. The enhancement of carbohydrate availability has been associated with fruit set and number of fruits per shoots which leads to increased yield attributes *viz.*, yield kg per plant and yield tons per hectare. These finding are in agreement with Wright (2000) and Shinde *et al.* (2014) in mango; Ahmad and Zargar (2005)

and Abu-Zahra (2010) in grape, Greenberg (2005) and El Khawaga (2007) in citrus; Mostafa and Saleh (2006) in mandarin and Haldankar *et al.* (2014) in jamun.

In control *vs* rest of the treatment analysis, girdled treatment gave maximum number of fruits per shoots and yield kg/plant, over the control. This might be due to the girdling interruption of the phloem pathway and hence temporarily stop the downward flow of carbohydrates, has been utilized experimentally for increasing fruit weight as well as increased pulp volume (ml), seems to be quantitatively correlated with carbohydrate availability (Goldschmidt *et al.*, 1985). The enhancement of carbohydrate availability has been associated with an improvement fruit weight (g) as well as increased pulp volume (ml) by more carbohydrate accumulation in girdled branches which leads to increased fruit yield kg per plant and tons per hectare. Similar findings were reported by Tuan *et al.* (2012) in apple; Goldschmidt *et al.*, (1999) and Goren *et al.*, (2003) in citrus and Braconi (1969) in olive.

All the interactions between girdling width and different treatments of girdling time were found non-significant in all the fruiting parameters.

### **5.3 Effect on quality parameters**

Different treatments of girdling width were non significantly affected on ascorbic acid (mg/100g). But, it was significant on TSS (<sup>0</sup>Brix), titrable acidity (%), reducing sugars (%) and total sugars (%). While, in case of girdling time ascorbic acid (mg/100g), titrable acidity (%), reducing sugars (%) and total sugars (%) were found non significant. While, it was significant with respect to TSS (<sup>0</sup>Brix) content.

Quality parameters of the fruit *viz.*, TSS, reducing sugars and total sugars were significantly maximum in 1.50 cm girdling width ( $W_4$ ) treatment and minimum conformed in 0.75 cm girdling width ( $W_1$ ) treatment. This might be due girdling blocked the translocation of sucrose from leaves to roots through phloem bundles (Li and Xiao, 2001). The temporarily blockage resulted in decrease in starch content of the roots and accumulation of sucrose in the leaves which helped to increase sucrose levels in fruits (Onguso *et al.*, 2004, Schneider, 1969, Plaut and Reinhold, 1967). These results are agreement with Reddy and Prakash (1989), Cheema *et al.* (1997), Dhillon and Bindra (1999), Ahmad and Zargar (2005), Said (2010) and Koshita *et al.* (2011) in grape; Rather *et al.* (2011) in litchi and Roussos and Tassis (2011) in citrus.

The data pertaining on acidity (%) was significantly minimum in 1.50 cm girdling width ( $W_4$ ) treatment and maximum acidity (%) was obtained in 0.75 cm girdling width ( $W_1$ ) treatment. This might be due to total sugar and starch contents were higher above the ringing than below the ringing which lead to decrease in titrable acidity (%) content of the fruits (Onguso *et al.*, 2004, Schneider, 1969, Plaut and Reinhold, 1967). This is in agreement with Rather *et al.* (2011), Rani and Brahmachari (2002) and Huang *et al.* (2012) in litchi; Day and DeJong (1990), Onguso *et al.* (2004) in peach; Khandekar *et al.* (2011) in jamun and Tuan *et al.* (2012) and Zhao *et al.* (2013) in apple.

Among different girdling time, 15<sup>th</sup> July of girdling time ( $T_1$ ) gave the significantly maximum content of TSS (<sup>0</sup>Brix) than later girdling treatments *i.e.*  $T_2$  (15<sup>th</sup> August) and  $T_3$  (15<sup>th</sup> September). This might be due to the earlier girdling resulted more response in carbohydrates accumulation, large amount of

carbohydrates produced by photosynthesis used to be utilized for fruit development ultimately which improved quality of the fruits. Similar findings were reported by Cheema *et al.* (1997) and Dhillon and Bindra (1999) in grape and Onguso *et al.* (2004) and Hossain *et al.* (2006) in peach.

Different girdling widths and girdling time on control *vs* rest of the treatment analysis concerned, significant variation was observed in quality parameters of the fruits *viz.*, TSS (<sup>0</sup>Brix), acidity and total sugars. This might be due to girdling blocked the translocation of sucrose from leaves to roots through phloem bundles. This way the block decrease starch content in root system and accumulated of sucrose in the leaves which help to increase sucrose levels of the fruits. (Onguso *et al.*, 2004) reported that sugar and starch contents were higher above the ringing than below which increases TSS (<sup>0</sup>Brix) and total sugar which lead to decreased in acidity (%) of fruits.

All the interactions between girdling width and girdling time were found non-significant effect with the all the quality parameters.

#### **5.4 Effect on leaf tissue analysis**

Different treatments of girdling width and different girdling time were did not reacted significantly to the leaf nutrient parameters *viz.*, nitrogen content (%), phosphorous content (%) and potassium content (%) in all cases. While, the significant effect were observed with report to content of carbohydrate in 15<sup>th</sup> October, 15<sup>th</sup> January and C: N ratio also.

Among the carbohydrates content (%) in leaves during 15<sup>th</sup> October and 15<sup>th</sup> January showed significant effect in 1.50 cm

girdling width ( $W_4$ ) treatment. This might be due to more stress by girdling or blocking of translocation of photosynthates (sugar and starch) from leaves to roots by making restriction of bark ringing in the trunk (Hossain, 2006). In which girdling interrupts the phloem pathway and hence large amount of carbohydrates produced by photosynthesis accumulated in vegetative organs above the girdled which leads to increase content of carbohydrates in leaf tissue (Onguso *et al.*, 2004). Similar trends were observed by Eltom *et al.* (2014) in grape and Mostafa and Saleh (2006) and Rivas *et al.* (2007) in citrus.

The data pertaining on C: N ratio in leaves were significantly maximum in 1.50 cm girdling width ( $W_4$ ) treatment and minimum C: N ratio in leaves obtained in 0.75 cm girdling width ( $W_1$ ) treatment. This might be due to girdling treatments continuously increased carbohydrates after girdling but there was failed to any significant effect on nitrogen (%) content of in leaves which decreased in leaf tissues. Which ultimately leads to increase C: N ratio in leaves in same treatment during 15<sup>th</sup> January. Similar trend was observed by Mostafa and Saleh (2006) in citrus.

Among different girdling time, 15<sup>th</sup> July of girdling time ( $T_1$ ) treatment gave the significantly maximum carbohydrate (%) during 15<sup>th</sup> October and 15<sup>th</sup> January and C: N ratio in 15<sup>th</sup> January than later girdling treatments *i.e.*  $T_2$  (15<sup>th</sup> August) and  $T_3$  (15<sup>th</sup> September). This might be due earlier girdling increased accumulation of carbohydrates above girdled portion. Onguso *et al.*, (2004) stated that girdling blocked the translocation of sucrose from leaves to roots through phloem bundles. Schneider, (1969) and Plaut and Reinhold, (1967) also revealed that the block decreased starch content in root system and accumulated of

sucrose in the leaves. The block decreased starch content in root system and accumulated of carbohydrates in the leaves. Due to that higher carbohydrates content increased C: N ratio in leaves in the same treatment. The similar confiding were reported by Mostafa and Saleh (2006) in citrus.

All the interactions between girdling width and different treatments of girdling time resulted in non-significant effect on all parameters of leaf nutrient parameters.

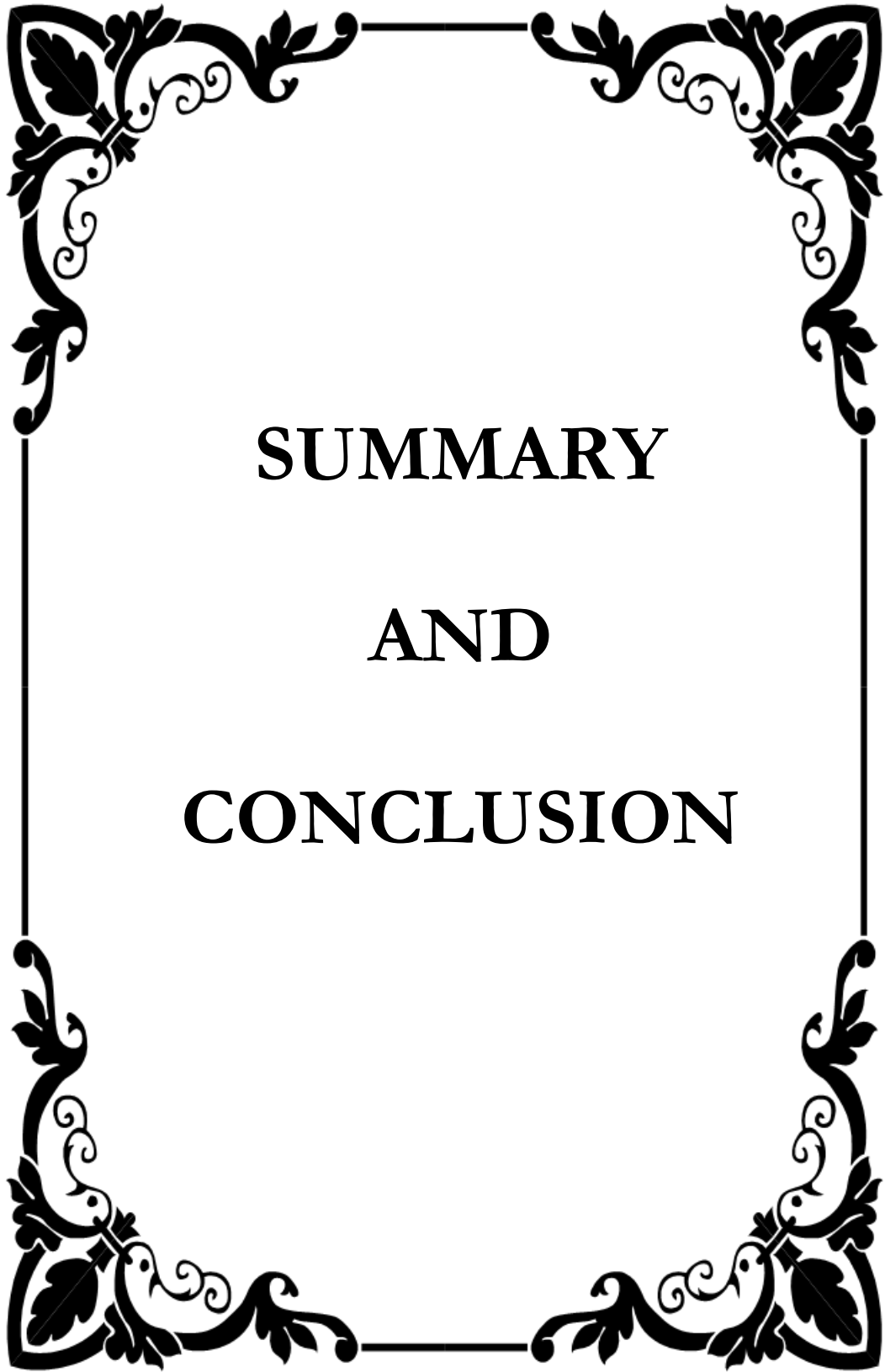
## 5.5 Economics

The mean data on economics were worked out for net realization and B: C ratio as influenced by different treatments of girdling width and girdling time.

Among the different girdling widths, maximum net realization and higher B: C ratio were observed in 1.50 cm girdling width ( $W_4$ ) treatment and minimum net realization and higher B: C ratio conformed in 0.75 cm girdling width ( $W_1$ ) treatment. This might be due to the girdling helps to more enhancement of carbohydrate availability and has been associated with an improvement fruit yield (Poll-van Der *et al*, 1991) which leads to increase in net realization and B: C ratio.

Among different girdling time, 15<sup>th</sup> July ( $T_1$ ) treatment gave maximum net realization and higher B: C ratio and minimum recorded in 15<sup>th</sup> September ( $T_3$ ) treatment. This might be due to the earlier girdling increased carbohydrates content in leaves which gave the maximum fruit yield (Poll-van Der *et al*, 1991) but cost of treatments and fixed costs were similar in all girdled treatments which lead to increase in net realization and higher B: C ratio.

In control *vs* rest of the treatment analysis, girdled treatment gave maximum net realization and B: C ratio over that control. This might be due to the enhancement of carbohydrate which was accumulated in girdled branches they may lead to increased fruit yield which resulted in net realization and higher B: C ratio.



**SUMMARY**  
**AND**  
**CONCLUSION**

## CHAPTER - VI

### SUMMARY AND CONCLUSION



The present investigation “Effect of time and width of girdling on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Alphonso” was carried out at Agriculture Experimental Station, Paria, Navsari Agricultural University, Paria, Dist. Valsad and at Regional Horticultural Research Station, Navsari Agricultural University, Navsari during 2014 - 2015.

The experiment was conducted with four girdling widths *viz.*, 0.75 cm (W<sub>1</sub>), 1.00 cm (W<sub>2</sub>), 1.25 cm (W<sub>3</sub>) and 1.50 cm (W<sub>4</sub>) and three girdling times *i.e.*, 15<sup>th</sup> July (T<sub>1</sub>), 15<sup>th</sup> August (T<sub>2</sub>) and 15<sup>th</sup> September (T<sub>3</sub>) along with untreated one control in randomized block design with factorial concept. The treatments were replicated thrice. The research results are summarized as under.

#### 6.1 Effect on flowering

1. Effect of different treatments of girdling width, girdling times and control *vs* rest of the treatment were unable to produce any significant impact on flowering parameters *viz.*, day required to flowering, length of shoots, hermaphrodite to male flower ratio, fruit drop percentages and days taken from to pea stage to maturity.
2. Significantly the maximum percentage of fruit set at harvest stage was recorded in 1.50 cm girdling width (W<sub>4</sub>) treatment while minimum percentage of fruit set was observed in 0.75 cm girdling width (W<sub>1</sub>) treatment.

3. Girdling during 15<sup>th</sup> July (T<sub>1</sub>) treatment produced significantly highest percentage fruit set at harvest stage. While, girdling in 15<sup>th</sup> September (T<sub>3</sub>) treatment produced significantly minimum fruit set percentage at harvest stage.
4. The control *vs* rest of the treatment, girdled treatments gave maximum fruit set percentage at harvest stage compared to control (un-girdled).
5. All the interactions between girdling width and girdling time were found non-significant in all the flowering parameters.

## **6.2 Effect on fruiting**

1. Different treatments of girdling width, girdling time and control *vs* rest of the treatment were non significantly affected on various fruiting parameters *viz.*, stone weight, peel weight and Pulp: Peel: Stone ratio.
2. Significantly the maximum fruit weight (g), volume of pulp (ml), number of fruits per shoot, yield (kg/plant) and yield (t/ha) were obtained in 1.50 cm of girdling width (W<sub>4</sub>) treatment and minimum were noted in 0.75 cm of girdling width (W<sub>1</sub>) treatment.
3. Girdling in 15<sup>th</sup> July (T<sub>1</sub>) treatment gave significantly maximum fruit weight (g), volume of pulp (ml), number of fruits per shoot, yield (kg/plant) and yield (t/ha), while minimum values were observed in 15<sup>th</sup> September (T<sub>3</sub>) treatment.
4. The control *vs* rest of the treatment, girdling treatments gave maximum fruit weight (g), volume of pulp (ml), number of

fruit per shoot, yield (kg/plant) and yield (t/ha) compared to control (un-girdled).

5. All the interactions between girdling width and girdling time were found non-significant in all the fruiting parameters.

### **6.3. Effect on Quality parameters**

- 1 Different treatments of girdling width were non significantly affected on ascorbic acid (mg/100g). But, it was significant on TSS (<sup>0</sup>Brix), acidity (%), reducing sugar (%) and total sugar (%). While, in case girdling time ascorbic acid (mg/100g), acidity (%), reducing sugar (%) and total sugar (%) were found non significant. While, it was significant on TSS (<sup>0</sup>Brix).
- 2 Significantly maximum TSS (<sup>0</sup>Brix), reducing sugar (%), total sugar (%) and lowest acidity (%) of the fruit were obtained in 1.50 cm of girdling width ( $W_4$ ) treatment. while minimum values were obtained in 0.75 cm girdling width ( $W_1$ ) treatment.
- 3 Girdling during 15<sup>th</sup> July ( $T_1$ ) treatment gave significantly maximum TSS (<sup>0</sup>Brix) of the fruits. While, minimum TSS (<sup>0</sup>Brix) was obtained in 15<sup>th</sup> September ( $T_3$ ) treatment.
- 4 The control *vs* rest of the treatment, girdling treatments gave maximum TSS (<sup>0</sup>Brix), total sugars (%) and lowest titrable acidity (%) compared to control (un-girdled).
- 5 All interactions between girdling width and girdling time were found non-significant with all the quality parameters.

#### 6.4 Effect on leaf tissue analysis

1. Different treatments of girdling width and girdling times were did not reacted significantly to the leaf nutrient parameters *viz.*, nitrogen (%), phosphorous (%) and potassium contents (%) in all the cases.
2. Different treatments of girdling width did not showed any significant effect on carbohydrate content (%) during 15<sup>th</sup> July and 15<sup>th</sup> October and C: N ratio in leaves at both the locations as well as pooled analysis.
3. Significantly maximum carbohydrate content (%) in leaf tissue during 15<sup>th</sup> October and 15<sup>th</sup> January were obtained in 15<sup>th</sup> July girdling (T<sub>1</sub>) treatment. While, minimum carbohydrate content (%) was noted in 15<sup>th</sup> September (T<sub>3</sub>) treatment.
4. Significantly the maximum carbohydrate content (%) in leaf tissue during 15<sup>th</sup> January was obtained in 1.50 cm of girdling width (W<sub>4</sub>) treatment. While, minimum carbohydrate content (%) in leaf tissue during 15<sup>th</sup> January was found in 0.75 cm of girdling width (W<sub>1</sub>) treatment.
5. Significantly maximum C: N ratio in leaves during 15<sup>th</sup> January was obtained in 15<sup>th</sup> July (T<sub>1</sub>) treatment and minimum C: N ratio was obtained in 15<sup>th</sup> September (T<sub>3</sub>) treatment.
6. The control *vs* rest of the treatment, girdling treatments gave maximum carbohydrate content (%) in 15<sup>th</sup> January compared to control (un-girdled).

7. All interactions between girdling width and girdling time were found non-significant effect with all the leaf nutrient parameters.

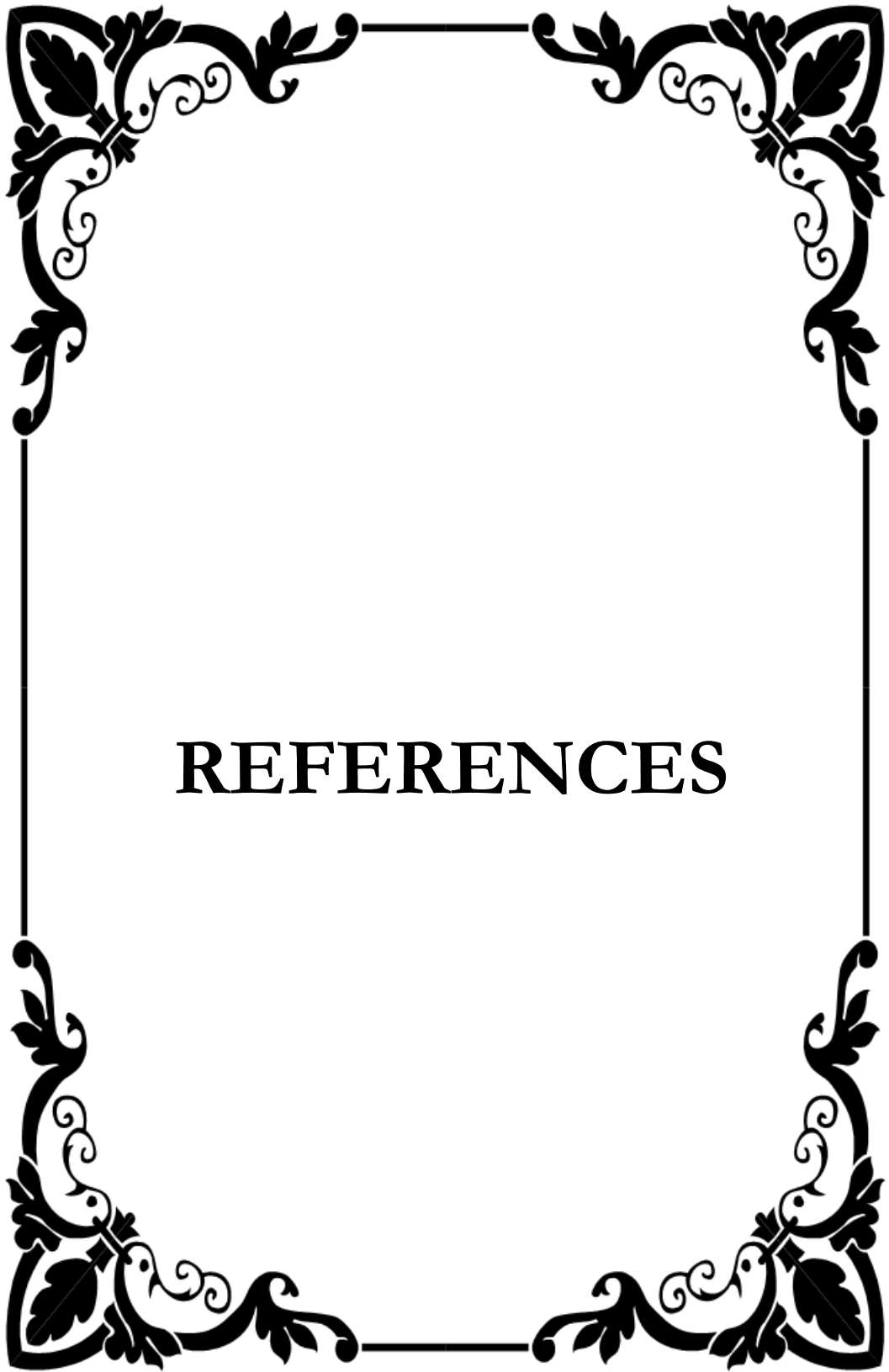
## **6.5 Economics**

- 1 Maximum net realization and higher B: C ratio were recorded in 1.50 cm of girdling width ( $W_4$ ) treatment. While, minimum net realization and B: C ratio noted in 0.75 cm of girdling width ( $W_1$ ) treatment.
- 2 Girdling in 15<sup>th</sup> July ( $T_1$ ) treatment gave maximum net realization and higher B: C ratio. While, the minimum net realization and B: C ratio were recorded in girdling during 15<sup>th</sup> September ( $T_3$ ) treatment.
3. The control *vs* rest of the treatment, girdling treatments gave maximum net realization and higher B: C ratio as compared to control (un-girdled)

### **Conclusion:**


On the basis of results obtained in the experiment “Effect of time and width of girdling on flowering, yield and quality of mango (*Mangifera indica* L.) cv. Alphonso”, it can be concluded that girdling during 15<sup>th</sup> July with 1.50 cm width gave maximum percentage of fruit set at harvest, fruit weight, pulp volume, number of fruits per shoots, yield kg per plant. estimated yield tons per hectare, total soluble solids, acidity, reducing sugars, total sugars, carbohydrate content in leaves during 15<sup>th</sup> October and 15<sup>th</sup> January as well as C: N ratio during 15<sup>th</sup> January and also the same treatment gave maximum net realization and higher B: C ratio.

From present study it can be inferred that the girdling during 15<sup>th</sup> July with 1.50 cm width were proved beneficial for improving fruiting and quality parameters of fruit as well as promoting carbohydrate content, C: N ratio in leaf tissues for maximum net realization and higher B: C ratio of mango cv. Alphonso.



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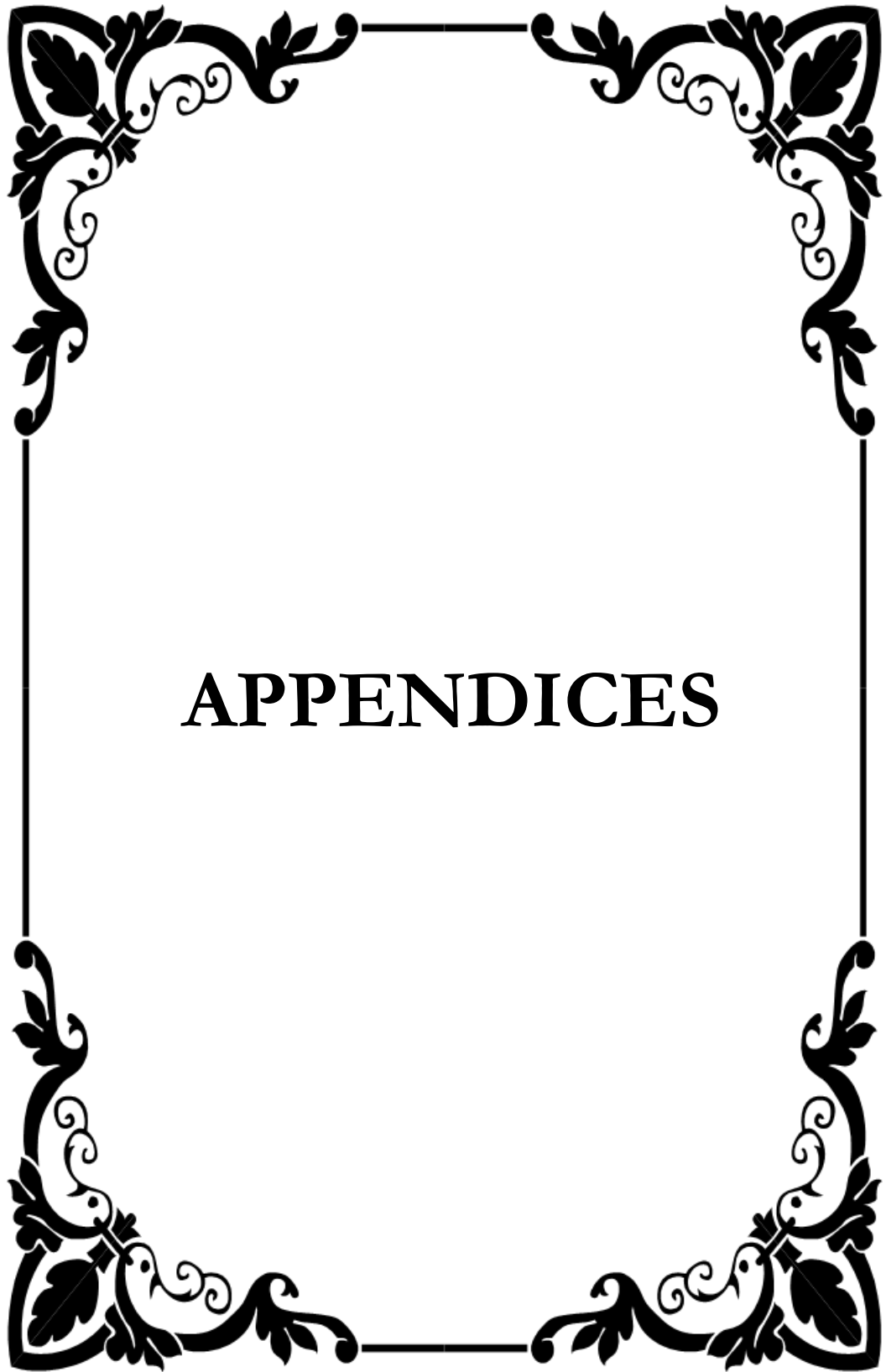
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\* Original not seen



# APPENDICES

## APPENDIX-I

### Standard week wise meteorological data of Paria during 2014-15

Std. week	Date	Rainfall (mm)	Temperature (C°)		Relative humidity (%)		Pan evaporation (mm)	Sunshine (hrs/days)	Wind speed (km/hr)
			Max.	Min.	AM	PM			
24	11-17	133.4	30.2	28.4	93.5	87.7	3.49	1.21	3.4
25	18-24	156.0	30.1	26.6	92.7	81.7	3.29	2.84	2.7
26	25-1	53.0	30.2	24.8	91.9	84.2	2.93	1.13	4.0
27	2-8	39.0	31.4	25.6	93.7	81.8	2.94	1.30	3.5
28	9-15	225.0	31.1	25.9	90.9	88.7	3.50	2.13	3.0
29	16-22	290.0	29.5	24.9	92.9	90.3	2.00	0.34	3.6
30	23-29	261.0	28.9	25.1	95.2	86.7	2.04	0.14	5.5
31	30-5	183.0	28.2	25.3	95.6	89.2	2.64	1.61	3.9
32	6-12	37.0	29.3	25.3	91.1	85.7	3.54	2.06	3.7
33	13-19	60.0	29.1	24.6	90.5	82.0	2.86	1.96	2.8
34	20-26	38.0	28.9	25.2	88.2	80.6	2.89	1.74	2.2
35	27-2	49.0	30.2	25.1	91.7	72.5	3.50	6.64	2.1
36	3-9	23.0	29.9	25.4	91.5	73.6	3.47	4.44	1.0
37	10-16	70.0	32.4	24.5	92.8	73.1	3.21	3.50	0.4
38	17-23	107.0	31.0	24.2	92.3	78.3	2.97	4.14	2.6
39	24-30	443.0	28.3	24.7	90.7	83.1	1.71	3.24	5.6
40	1-7	32.0	30.6	25.2	92.4	78.0	2.96	4.36	1.4
41	8-14	11.0	30.8	24.0	91.6	73.6	2.59	4.71	0.3
42	15-21	2.0	34.3	25.0	84.0	42.9	3.31	8.00	1.9
43	2-28	0.0	34.9	24.2	76.2	42.9	3.51	9.69	3.3
44	29-4	0.0	34.4	22.7	80.5	31.7	3.53	9.64	1.8
45	5-11	0.0	34.4	20.6	80.0	36.7	3.53	8.14	2.3
46	12-18	0.0	32.1	19.1	72.2	34.5	4.07	7.77	3.6
47	19-25	0.0	33.7	19.9	65.9	46.5	4.29	9.27	3.5
48	26-2	0.0	33.8	18.8	68.5	38.7	4.57	8.07	4.5
49	3-9	0.0	32.5	17.7	74.8	34.3	3.60	7.74	3.1
50	10-16	0.0	31.2	21.5	94.1	44.1	3.51	8.86	2.7
51	17-23	0.0	29.9	16.8	88.9	72.1	3.41	8.33	2.3
52	24-31	0.0	29.4	12.9	80.9	44.6	3.14	5.89	3.4

## APPENDIX-II

### Standard week wise meteorological data of Navsari during 2014-15

Std. week	Date	Rain-fall (mm)	Temperature (C°)		Relative humidity (%)		Pan evapo - ration (mm)	Sunshine (hrs/day)	Wind speed (km/hr)
			Max.	Min.	AM	PM			
23	4-10	0.0	34.3	28.9	85.0	64.5	6.5	9.0	9.5
24	11-17	28.0	33.6	26.0	84.9	69.3	6.4	7.6	8.1
25	18-24	8.0	32.4	28.3	81.6	65.7	6.1	6.1	11.6
26	25-1	0.0	33.8	28.2	76.0	59.3	15.1	8.7	7.3
27	2-8	21.0	33.5	26.5	84.3	65.8	6.0	7.4	9.8
28	9-15	40.5	31.0	25.1	91.8	74.9	5.3	4.8	7.9
29	16-22	221.5	29.7	26.0	91.1	84.5	3.2	1.2	9.8
30	23-29	282.0	29.7	24.9	87.2	86.2	3.2	1.6	10.4
31	30-5	268.5	28.6	25.7	93.4	86.4	2.6	1.8	8.8
32	6-12	64.5	29.7	24.8	92.3	79.3	3.9	3.8	8.4
33	13-19	40.0	30.1	25.3	89.2	77.4	2.6	3.6	8.5
34	20-26	24.0	32.2	25.6	94.5	77.1	3.5	3.9	2.6
35	27-2	120.0	29.7	24.3	96.9	85.5	2.9	0.7	3.1
36	3-9	61.0	29.8	25.3	93.1	83.0	3.0	3.5	9.4
37	10-16	278.0	29.7	24.2	95.9	78.1	2.6	2.8	4.1
38	17-23	1.0	32.0	24.3	90.5	70.4	3.9	6.4	3.6
39	24-30	0.0	34.4	24.6	89.8	68.2	3.8	6.4	2.7
40	1-7	0.0	36.7	24.4	83.1	40.9	4.5	8.1	3.1
41	8-14	0.0	36.4	22.5	85.5	42.2	4.0	8.6	3.4
42	15-21	0.0	36.4	22.5	87.8	47.8	4.6	9.8	2.9
43	22-28	0.0	34.6	21.3	75.4	36.2	4.7	6.7	3.1
44	29-4	0.0	35.3	19.4	89.5	42.3	4.5	9.0	2.3
45	5-11	0.0	34.1	18.8	80.2	38.2	4.5	8.6	2.6
46	12-18	67.0	32.7	22.7	90.0	58.2	3.4	5.4	2.7
47	19-25	0.0	33.2	18.9	82.4	43.1	3.6	8.7	2.2
48	26-2	0.0	33.0	15.5	83.2	32.9	3.3	8.8	1.9
49	3-9	0.0	32.6	15.7	69.4	37.0	3.7	8.8	3.0
50	10-16	0.0	30.2	14.0	81.9	47.9	3.1	6.6	2.9
51	17-23	0.0	29.3	13.2	70.5	47.8	3.2	7.6	5.0
52	24-31	0.0	29.0	13.0	68.7	33.2	3.2	8.0	3.9

**Appendix - III**  
**Expenditure details of mango cultivation**

	Particulars	Quantity	Rate	Cost (Rs/ha)
<b>A) Fixed cost expenditure</b>				
1.	Land preparation			
	I. Ploughing	9 hrs	Rs. 350 /hr	3150
	II. Harrowing	9 hrs	Rs. 250 /hr	2250
2.	Irrigation	2 times	Rs. 1500 /hr	3000
3.	Fertilizers			
	I. Organic fertilizer (100 kg/tree)			
	1. FYM	10 t	Rs. 490 /t	4900
	2. Labour for application	100 tree	Rs. 7 /tree	700
	II. Inorganic fertilizers (750-160-750 g NPK/tree)			
	1. Urea	163 kg	Rs. 6 /kg	978
	2. SSP	96 kg	Rs. 7 /kg	672
	3. MOP	120 kg	Rs. 17 /kg	2040
	4. Labour for application	100 trees	Rs. 7 /tree	700
4.	Plant growth regulator			
	Paclobutrazol (20 ml/tree)	2 L	4500 Rs/L	9000
	Drenching charges	100 tree	7 Rs/tree	700
5.	Plant protection measures			
	Imidacloprid (2.7 ml/10 L water)	2 L	Rs. 1200 /L	2400
	Sulphur wt. (25 g/10 L water)	7.5 kg	Rs. 200 /kg	1500
	Carbendazim	8 kg	Rs. 700/kg	5600
	Acephate (15 g/ 10 L water)	6 kg	Rs. 700 /kg	4200
	Hexaconazol (10 ml/ 10 L water)	8 L	Rs. 450 /L	3600
	Labour charge for spraying	2 Spray	Rs. 275 /Spray	550
			Total	45,940
<b>B) Treatment cost expenditure</b>				
	Particulars			
1.	Copper oxychloride (COC)	1 kg	Rs. 500 /kg	500
2.	Labour charges for treatment	6 labour	200 / labour	1200
3.	Harvesting cost	-	1.0 / kg	-
4.	Selling price of fruits	-	Rs. 30 /kg	-

**C E R T I F I C A T E**

*This is to certify that I have no objection to supply one copy of any part of this thesis at a time to any scientist through reprographic process if necessary for rendering reference service in a library or documentation centre.*

**Place:** Navsari

**Date:** March 28, 2016

**(Ghadage Nitish Jagannath)**