Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L- 49 Fruits

THESIS

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Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior

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In

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(FRUIT SCIENCE)

By

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CERTIFICATE- I

This is to certify that the thesis entitled **"Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L- 49 Fruits"** submitted in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE (Fruit Science)** of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya Gwalior (M.P.) is a record of the bona fide research work carried out by **Mr. Saransh Saxena** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and Director Instruction.

No part of the thesis has been submitted for any other degree or diploma or has been published. All the assistance and help received during the course of this investigation has been acknowledged by the scholar.

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CERTIFICATE- II

This is to certify that the thesis entitled **"Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L- 49 Fruits"** submitted by **Mr. Saransh Saxena** to the Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior, in partial fulfilment of the requirements for the degree of **Master of Science (Agriculture)** in **Horticulture** in the **Department of Fruit Science,** has been, after evaluation by the External Examiner and approved by the Student's Advisory Committee after an oral examination on the same.

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Place - Mandsaur (M.P.)

Date- ………/………./…………….

(Saransh Saxena)

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List of abbreviations/ symbols

Symbol	Abbreviation	Stands for
%		Per cent
/		Per
^{o}		Degree
-	ANOVA	Analysis of Variance
-	^{o}B	Degree Brix
-	^{o}C	Degree Celsius
-	$CaCl_2$	Calcium Chloride
-	Cm	Centimeter
-	cv.	Cultivar
-	DF	Degree of Freedom
-	*et al.*	*et allia;* and others
-	etc.	Etcetra
-	Fig.	Figure
-	G	Gram (s)
-	Ha	Hectare
-	*i.e.*	that is
-	Kg	Kilogram (s)
-	M	Meter
-	Max.	Maximum
-	Min.	Minimum
-	Mg	Miligram
-	ml	Milliliter
-	MT	Metric ton
-	NHB	National Horticulture Board
-	pH	Potential of hydrogen ions
-	ppm	parts per million
-	RBD	Randomized Block Design
-	RH	Relative humidity
-	Temp.	Temperature
-	TSS	Total Soluble Solids
-	var.	Variety
-	*Viz.*	*Videlicet*/ Namely

CHAPTER - I

INTRODUCTION

Guava (*Psidium guajava* L.) is one of the important fruit cultivated in several tropical and subtropical countries of the world (Pathak, *et al.,* 2007), it belongs to the family Myrtaceae, originated in Tropical America. It is also known as 'Apple of the tropics' or 'Poor man's apple'. Due to hardy nature of the guava fruit plant, it can withstand upto adverse climatic conditions and grows under a wide range of soil types from sandy loam to clay loam (Dhaliwal and Singla, 2002).

In India, Guava is the fourth most important fruit crop in area and production after mango, banana and citrus with production of 42.36 lakhtonnes from an area of 2.76 lakh ha (NHB Database, 2018). It is an important fruit crop cultivated all over India, especially in the regions of Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra, West Bengal, Punjab, Chhattisgarh, Haryana, Karnataka, and Gujarat.

Allahabad of Uttar Pradesh is known for growing best quality guava fruits in the world (Maji, 2010). In Madhya Pradesh major guava producing areas are Sagar, Shahdol, Sehore, Sheopur, Indore, Hoshangabad and Mandsaur. In Madhya Pradesh, the area covered is around 35.08 thousand ha with a production of 686.70 thousand MT of guava crop (Anonymous, 2018).

Its roots, bark, leaves and fruits have a great medicinal value. The fruit is an excellent source of vitamin C, pectin, calcium and phosphorus. Guava is the most important as well as protective fruit in India for having highest vitamin C (299 mg/100g) among table fruits (Bal *et al.,* 2014). It is normally consumed fresh as a dessert fruit, or processed into puree, juice, concentrate, jam, jelly, nectar or syrup (Jagtiani *et al.,* 1988).

Guava fruit of variety Lucknow-49 is a slection from open pollinated population of Allahabad Safeda cultivar from Ganeshkhind, Pune (MH) and is also called as Sardar Guava. Trees are vigorous. The leaves are elliptical-ovate to oblong in shape. Fruits are roundish ovate in shape. Skin color is primrose-yellow. The pulp is whitish, very sweet and tasty with a TSS of 9.5 ^{0}B and vitamin C content 130 mg/100 g. It has been observed that pectin content is higher in winter guava than the monsoon fruits (Salunke and Kadam, 1995).

The production of low quality fruits is a matter of common experience. It would be therefore worthwhile to improve the quality of guava by foliar application of pre harvest spray. They are readily absorbed and move rapidly through the tissues, when applied to different plant parts. These chemicals are specific in their action. Thus the use of pre harvest plant spray has resulted in some outstanding achievements with respect to growth, yield and quality.

Pre-harvest calcium spray is one of the most important practices of new strategies applied in the integrated fruit production systems, improving fruit characteristics to minimize fungicides sprays towards the end of the harvest period, which in turn improves fruit resistance to brown rot (Conway *et al.,* 1994). Calcium spray during fruit development provides a safe mode of supplementing endogenous calcium to fresh fruits (Singh *et al.,* 1993; Gerasopoulos *et al.,* 1996; Tzoutzoukou and Bouranis 1997; Raese and Drake 2000).

Application of Ascorbic acid had many stimulating effects on growth and physiological activities of various plants (Dewick, 2000, Ismail, 2008 and Abdou *et al.,* 2015). Various researchers revealed the Ascorbic acid as an effective measure in controlling enzymatic browning of fruits and vegetables (Santerre *et al.,* 1988; Sapers *et al.,* 1989). Ascorbic acid is a good antioxidant that keeps fruit from darkening and improves destruction of bacteria. Antioxidants are used instead of auxins for improving fruit growth, development and fruiting of trees (El Sayed *et al.,* 2000 and Maksoud *et al.,* 2009). Nowadays, there is a wide use of antioxidants especially ascorbic acid as natural and organic antioxidant compound. Ascorbic acid is an essential compound for plant tissues since it has antioxidant functions, and acts as co-enzyme in an enzymatic co-factor and plant growth regulator.

Fruit bagging decreases the defects generated due to diseases and insects, and increased flesh firmness and flavour. The most important role of fruit bagging was to effectively protect fruits from physiological factors which led to the significant decrease of the total damaged, degenerative and defective fruits (13.7-33.3%), as compared with non-bagging fruits.

Bagging is a physical protection technique used extensively in several fruit crops to improve skin colour which also reduce the incidence of disease, insect-pests, mechanical damage, agrochemical residues on the fruit, and bird damage (Bentley and Viveros, 1992; Kitagawa *et al.,* 1992; Hofman *et al.,* 1997; Joyce *et al.,* 1997; Tyas *et al.,* 1998; Amarante *et al.,* 2002a; Xu *et al.,* 2010).

Bagging not only protects fruit from pests and diseases but also affects the quality of the produce by changing micro-environment of fruit during development (Son and Lee, 2008) and yields high quality fruit (Kitagawa *et al.,* 1991).

However negligible research works have been conducted on safe guava production techniques and handlings. Therefore this study has been undertaken to explore the effects of different bagging materials on physical and chemical quality of guava in a view to judge the potential of fruit bagging technology for safe guava production.

Hence, keeping the above facts in view, an experiment entitled **"Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L- 49 Fruits"** was conducted at *Instructional cum Research Fruit Orchard*, Department of Fruit Science, K.N.K. College of Horticulture, Mandsaur (M.P.) during 2019-20 with following objectives:

1. To study the effect of pre-harvest treatments and bagging for physical parameters of guava fruits,
2. To study the effect of pre-harvest treatments and bagging for bio-chemical parameters of guava fruits and
3. To study the effect of pre-harvest treatments and bagging for organoleptic test of guava fruits.

CHAPTER - II

REVIEW OF LITERATURE

The present chapter deals with the review of work carried out by various researchers. In this chapter an attempt has been made to review the work of different concentrations of $CaCl_2$ (Calcium Chloride), Ascorbic acid and different types of bagging on quality improvement of guava fruits.

The literature on research work carried out in Madhya Pradesh, India and abroad on the "**Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L- 49 Fruits"** and other fruits have been reviewed.

Chéour *et al.* (1990) studied the effects of $CaCl_2$ pre-harvest treatment on postharvest strawberry (*Fragaria* × *ananassa*) cv. Tribute and found that Calcium treatment caused a significant increase in fruit and leaf Ca contents, which were closely correlated. Ca treatment delayed ripening and gray mold development. The delay increased with increasing Ca concentration.

Penter and Stassen (2000) revealed the effects of both preharvest and postharvest calcium applications on the quality of Pinkerton avocados. The series of trials carried out indicates that a number of benefits are derived from calcium applications. One such factor is fruit maturity. The work indicated that pre-harvest applications are more effective in the development of the fruit.

Jayachandran *et al*. (2005) noticed that pre-harvest spray of calcium compounds reduced Physiological Loss in Weight and titratable acidity, while they increased TSS, reducing sugars and pectin contents. However, higher concentration of calcium nitrate was more effective than other treatments. The fruit firmness increased as the concentration of calcium increased in the fruits.

Rajput *et al.* (2008) observed that the shelf life of guava fruits increased with the increase in concentration of calcium compounds and bavistin. The maximum TSS, ascorbic acid, pectin content and minimum titrable acidity of guava fruits was obtained under 2.0% calcium nitrate pre-harvest spray and 2.0% calcium nitrate post-harvest dip. Pre and post-harvest application of calcium compounds and bavistin significantly affected the shelf-life of guava fruits.

Sarker *et al.* (2009) evaluated for the control of mango fruit fly attacking Langra and Khirshapat variety at the mango orchards of Mango. Though all bagging materials gave 100% protection of mango fruits against the fruit fly infestation, bagging of fruits with brown paper bag was found to be the best in protecting mango fruits and provides almost similar % Total Soluble Solid (TSS) and physical fruit quality in bagged fruits when compared with the un-bagged healthy fruits of the control treatment.

Kassem *et al.* (2011) studied the effect of polyethylene bagging on fruit ripening, improved productivity and postharvest fruit quality of palm date. Polyethylene bagging with removing at later growth stages caused a significant early fruit ripping date, increased fruit weight, length, diameter and yield, as well as decreased the percentage of tip cracked fruits at harvest time comparing with no bagging control.

Zhou *et al.* (2012) studied the effects of bagging with different bags to the clusters on fresh fruit quality in Xiangtian olive of *Canarium album* indicated that, the color and smoothness were better, the edible pulp rate and ascorbic acid concentration were higher after bagging than in the control during the two years' experiments, but the fruit soluble solids were decreased. It showed that the golden yellow color, more smoothness, higher single fruit weight, more delicate flesh and better degree of slag for the fruits were obtained with Shengda double-layer bags especially in Xiangtian olive of *Canarium album.*

Bakshi *et al*. (2013) studied the pre-harvest foliar application of calcium (Ca), iron (Fe) and zinc (Zn), influences vegetative growth, flowering, fruit yield and quality on Chandler cultivar of strawberry (*Fragaria* × *ananassa* Duch.). Results revealed that treated plants were ascorbic acid (60.88 mg/100g pulp), TSS:acid ratio (11.70) and lowest acidity (0.716 %). Pre-harvest foliar application of calcium, iron and zinc are quiet useful for improving vegetative growth, quality and shelf-life of strawberry cv. Chandler.

El-Badawy (2013) found that fruiting parameters i.e. fruit set and fruit yield (kg/tree) were greatly enhanced by the antioxidants and micronutrients as well as their combinations in both seasons. Moreover, the best results of fruiting parameters were existed with high level of antioxidant and micronutrient combinations in both seasons. Furthermore, the heaviest fruit weight (g) and the highest T.S.S. %, values as well as the lowest value of total acidity % were scored by the high level of antioxidants and macronutrients as well as their combinations in Canino apricot tress.

Jakhar and Pathak (2014) conducted an experiment to improve the fruit quality and reduce the black spotting in Amrapali mango with pre harvest foliar spray of $CaCl_2$ @2% and K_2SO_4 @1% and fruit bagging. Fruit bagging with brown paper bag was employed at 20 days before harvesting of fruits. The results indicated that the spray of 2% $CaCl_2$ and 1% K_2SO_4 combined with bagging was found superior to increase the quality of fruits in respect of fruits weight, TSS, ascorbic acid and TSS acid ratio and highest organoleptic quality among all treatments in both session.

Karemera and Habimana (2014) revealed that spraying of $CaCl_2$ delayed the process of ripening of fruits when compared to fruits from control trees. Mango cv. Totapuri took more number of days for ripening (19.89 days) when trees were sprayed with 1.50% $CaCl_2$ at 30 days before harvest and also physico-chemical proprieties were improved compare to fruits from non-sprayed trees.

Karemera and Habimana (2014) concluded that 1.50% $CaCl_2$ significantly increased the number of days taken for ripening of fruits, the shelf-life of fruits, physico-chemical parameters and organoleptic evaluation of mango fruits compared to control.

Madani *et al.* (2014) reported that higher calcium chloride concentrations in the sprays coincided with increasing calcium chloride concentrations in peel and pulp tissues, higher firmness and titratable acidity, and reduced respiration rate, ethylene production and soluble solids concentrations, compared with those of the untreated control fruits. The overall quality of fruits treated with calcium was greater than the control fruits of papaya.

Nagaharshitha *et al.* (2014) results showed that the chemical parameters such as acidity, TSS, reducing, non-reducing sugars and β carotene were not significantly varied due to bagging.

Sharma *et al.* (2014) found that pre-harvest fruit bagging has emerged as an effective method. Bagging is a physical protection method which not only improves the visual quality of fruit by promoting skin colouration and reducing blemishes, but can also change the micro-environment for fruit development, which can have several beneficial effects on internal fruit quality. Pre-harvest bagging of fruit can also reduce the incidence of disease, insect pest and/ or mechanical damage, sunburn of the skin, fruit cracking, agrochemical residues on the fruit and bird damage.

Omar and El-Shemy (2014) revealed that bagging is a physical technique commonly used with many crops to both protect fruits from diseases and pests and to alter the microenvironment of fruit development. Bagged and unbagged fruits were evaluated for fruit quality during stages of fruit development. Bagging modified the microenvironment of the fruit, increasing humidity, this remained above 70% between two and three weeks after bagging. Bagging also increased temperature and promoted fruit development, increased the final fruit retention percentage, and improved fruit yield and quality (both physical and chemical characteristics). Based on the results, bagging is recommended as a pre-harvest treatment to promote early ripening and improve fruit quality of Zaghloul date palms.

Behera and Pathak (2015) noticed that various pre-harvest treatments spraying of $CaCl_2$ 2% + polythene bagging, spraying of $CaCl_2$ 2% + brown paper bagging, spraying of $CaSO_4$ 2% + polythene bagging, spraying of $CaSO_4$ 2% + brown paper bagging increased quality of guava fruits significantly. Among the treatments, $CaCl_2$ 2% + polythene bagging proved the best in enhancing post-harvest quality attributes viz. fruit size, fruit weight, fruit firmness, organolaptic quality, Total Soluble Solids (TSS), acidity, TSS:

acid ratio, ascorbic acid, reducing sugars, non reducing sugars and total sugars.

Jakhar and Pathak (2016) conducted study on the effect of pre-harvest bagging and spray of $CaCl_2$ and K_2SO_4 on quality and shelf life of mango fruits cv. Amrapali during two succeeding years. The results indicated that the pre-harvest treatment of 2% $CaCl_2$+1% K_2SO_4+bagging was found superior to improve the quality of fruits in respect of highest fruits weight, firmness, TSS, ascorbic acid, total sugars. Fruits treated with 2% $CaCl_2$+1% K_2SO_4+bagging showed highest organoleptic quality as against 6 days of untreated fruits (control).

Joshi et al. (2016) noticed that brown paper bag and butter paper bag were effective in minimum acidity (0.51%) while TSS (19.5 ^{0}B), ascorbic acid (21.56 mg/100gm), reducing sugar (11.31%) and total sugar (13.13%) were found maximum in fruits bagged in green polyethylene bag. Hence, brown and butter paper bags and green polyethylene bag were found effecive in improving fruit colour and maintaining fruit quality at harvest.

Meena *et al.* (2016) observed that fruit bagging in general, improved the growth and quality development of guava fruits as compared to unbagging control. It was also observed that fruit size, weight and pulp content increased due to fruit covering. Fruit was found maximum in size under yellow polythene followed by white polythene while, black polythene showed maximum pulp percentage followed by green polythene. Fruit bagging also improved the fruit quality in terms of TSS and TSS: acid ratio which were found maximum (14.25 °Brix, 11.14% and 30.07, respectively) under yellow polythene but, maximum vitamin C (171.14 mg 100 g-1) content was recorded under white polythene. Among the various fruit covering materials bagging with yellow coloured polythene was found to be the best for overall improvement of physico-chemical quality of winter season guava.

El-Badawy *et al.* (2017) investigated that ascorbic acid 1g/L+ mixture of micronutrients 1.5g/L + Mixture of macronutrients 3g/L was statistically the superior for Washington navel orange trees during two experimental seasons. On vegetative growth (No. of shoots/ one-meter limb, shoot length &

thickness, No. of leaves per shoot, leaf area and assimilation area per one shoot) and nutritional status (leaf N, P, K, Ca, Mg % and Fe, Mn and Zn ppm).

Abdel *et al.* (2017) studied the effect of bagging type on reducing Keitt mango fruit disorders and improving fruit quality. The obtained results showed that, bagging fruits with agrail red bag increased number of fruits per tree, fruit weight, yield per tree and vitamin C content. While, the number and weight of sunburn fruits/ tree was reduced as compared to the other treatments. Moreover, bagging fruits with agrail green bag increased fruit length, fruit thickness, TSS %. On the other hand, bagging fruits with news paper bag increased fruit firmness and total acidity percentage.

Patel *et al.* (2017) observed that the spraying of $CaCl_2$ @ 1% found effective for increasing total soluble solids, total sugar, reducing sugar, non-reducing sugar, ascorbic acid with minimum acidity and moisture content of sapota fruits. While, pre-harvest spraying of $CaCl_2$ @ 1.5% improved calcium content of sapota fruits.

Mishra *et al.* (2017) found that the physiological loss in weight after harvest was minimum under calcium chloride 1% closely followed by calcium chloride 1.5%. Maximum fruit firmness was also observed with the application of potassium sulphate 0.6% and minimum found in calcium chloride 1% in guava cv. L-49.

Singh *et al.* (2017) reported that organoleptic test, colour (7.33) and taste (7.47). It is concluded from the present study that the under South Gujarat condition, Fruits were bagging with brown paper bag, gave better results in chlorophyll, Organoleptic evaluation parameters.

Taduri *et al.* (2017) sprayed with 75 ppm GA_3 at 20 DBH (T3) and 1.50% $CaCl_2$ result revealed that spray of 75 ppm GA_3 at 20 DBH and spray of 1.50% $CaCl_2$ at 20 DBH significantly improved the physico-chemical parameters and organoleptic evaluation of mango cv. Amrapali fruits compared to control.

Abbasi *et al.* (2018) noticed that bagging techniques can protect fruits from pests and eliminates the use of pesticides, thus improves the quality of fruit, by different materials viz. newspaper bags, perforated polyethylene bags, muslin cloth bags and netted cloth bags used for on-tree bagging of guava fruit to improve fruit quality. The maturity of the fruit remained at par in bagged and unbagged fruits except newspaper bags where it was delayed significantly. Polyethylene bags reduced the damage by fruit fly to maximum extent followed by newspaper and muslin cloth bags. Moreover, newspaper bagged fruit exhibited the lowest weight loss (2.72%) and highest pH (4.35) during storage. Amongst various bagging treatments the perforated polyethylene was found to be the best regarding sensory evaluation.

Kireeti *et al.* (2018) found that fruits bagged with Newspaper bag and Brown paper bag recorded maximum fruit length (12.78 and 12.29 cm), fruit weight (263.67 g and 248.22 g) and pulp weight (188.83 g and 179.76 g) respectively.

Prabha *et al.* (2018) concluded that the fruit length with crown was found maximum (25.43 cm) in paper bag and the minimum (22.33 cm) was observed in transparent polythene bag, Fruit length without crown was recorded maximum (18.24 cm) in black polythene and minimum result was found in control (15.80 cm). Highest (677.89 g) fruit weight without crown was obtained in paper bag whereas lowest (462.03 g) was reported in transparent polythene bag. Meanwhile in fruit chemical parameter maximum TSS (ºBrix) was observed highest (14.22) in paper bag and lowest was observed in control (12.35). Overall by considering the results it was reported that paper bag was better option for fruit bagging of pineapple cv. Mauritius for prominence effect on yield and quality.

Rahman *et al.* (2018) noticed that maximum gain in size i.e. 6.59 cm length, 5.86 cm diameter and 164.26 g weight under white paper bag followed by white polythene bag (131.3 g). Total Soluble Solids concentration of the fruit was found to be the maximum (12.33 ^{0}B) under brown paper bag while the maximum vitamin C concentration (162.14mg /100g) was recorded under white paper bag in guava fruit.

Sharma *et al.* (2018) revealed that all pre harvest treatments found superior than control the pre harvest treatment of polythene + salicylic acid@ 3 % proved the most efficient in improving fruit size and weight (length 5.37

cm and width 5.23 cm), weight (133 g), and treatment violet polythene + $CaCl_2$ @ 2% improve the bio-chemical quality, TSS (12.68 %), acidity (0.48 mg/100g), TSS: acid ratio (30.19 %), ascorbic acid (164.67 mg/100g) in guava fruit.

Singh and Mirza (2018) said that quality cannot be improved during storage contributing to the list of protectants, ascorbic acid finds suitability as a preferential post-harvest dip agent for shelf-life enhancement and keeping the fruit properties intact for longer durations in different fruit crops.

Islam *et al.* (2019) revealed that the result bagged at 35 days after fruit set with white paper and brown paper bag recorded maximum fruit length (97.93 and 103.5 mm), fruit diameter (79.27 and 84.85 mm), fruit weight (311.66 g and 329.2 g), pulp weight (278.9 g and 289.8 g) respectively, and minimum result was found in polythene bag and control. Meanwhile in fruit chemical parameter of Total Soluble Solids, ascorbic acid and pH were improved over control. Brown paper bag changed fruit color. The sensory qualities in fruits of brown and white paper bags were improved over control. Fruits treated with brown paper bag showed good physical quality as against of unbagged fruits (control).

Aly *et al.* (2019) studied the effect of pre-harvest foliar application with Putrescine, ascorbic acid, salicylic acid and citric acid at 200, 400, 600 ppm and control (water only) on fruit quality and storability of results showed that, TSS, vitamin C, firmness and anthocyanin contents were significantly increased. Moreover, Putrescine at 600 ppm and salicylic acid, ascorbic acid and citric acid at (400 and 600) ppm were more effective on improving fruit quality at harvest of “Anna” apple in both seasons. It could be concluded that, preharvest spraying with Putrescine, ascorbic acid, salicylic acid and citric acid led to markedly increase quality at (2˚ C with 85-95% R.H.) of “Anna” apple fruits.

CHAPTER - III
MATERIALS AND METHODS

The present experiment entitled **"Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L-49 Fruits"** was conducted at the *Instructional cum Research Fruit Orchard*, Department of Fruit Science, K.N.K. College of Horticulture, Mandsaur (M.P.).

The methods employed during the course of investigation and materials utilized have great significance in the research programme. The details of material used and techniques employed in carrying out the investigation are described under the following heads:

3.1 Location:

The experiment was conducted at the K.N.K. College of Horticulture, Department of Fruit Science, Mandsaur (M.P.), Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.). Mandsaur is situated at 23.45^0 to 24.13^0 N latitude and 74.44^0 to 75.18^0 E longitudes at an altitude of 435 m Mean Sea Level. The location of the experimental farm is situated in the main campus of college, it is located on the Mandsaur– Sitamau road adjacent to the Sitamau railway crossing phatak. It is also well connected by the Indore and Ratlam road.

3.2 Climatic Conditions:

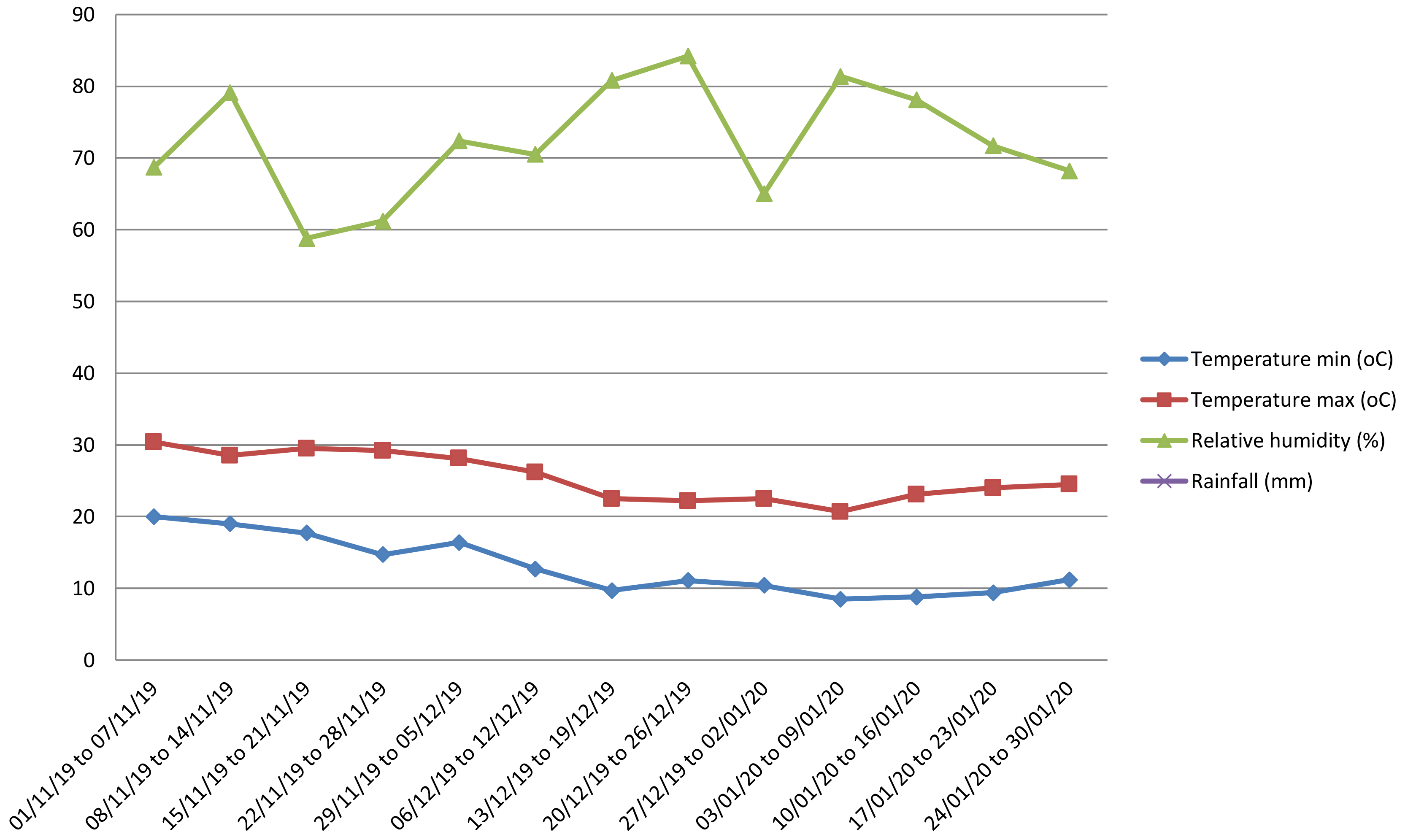
Mandsaur has a subtropical climate with hot summer and cool winter. The temperature rises up to 46^0C during summer and falls to 3.6^0C during winter with an occasional occurrence of frost. The average rainfall is 797.6 mm, most of which occur during July to September, winter and summer rains are uncommon. The mean of weekly values of weather parameter during the period of investigation (2019-2020) were recorded at the Meteorological Observatory at the Bahadari Farm of College of Horticulture Mandsaur. The concerned meteorological data are presented in Table 3.1 and graphically represented in Figure 3.1.

Table- 3.1: Weekly meteorological data recorded during the course of investigation (November, 2019 to January, 2020)

Week	Temperature ^0C		Relative humidity %	Rainfall (mm)
	Min.	Max.		
01/11/19 to 07/11/19	20	30.4	68.7	-
08/11/19 to 14/11/19	19	28.5	79.1	-
15/11/19 to 21/11/19	17.7	29.5	58.8	-
22/11/19 to 28/11/19	14.7	29.2	61.2	-
29/11/19 to 05/12/19	16.4	28.1	72.4	-
06/12/19 to 12/12/19	12.7	26.2	70.5	-
13/12/19 to 19/12/19	9.7	22.5	80.8	-
20/12/19 to 26/12/19	11.1	22.2	84.2	-
27/12/19 to 02/01/20	10.4	22.5	65	-
03/01/20 to 09/01/20	8.5	20.7	81.4	-
10/01/20 to 16/01/20	8.8	23.1	78.1	-
17/01/20 to 23/01/20	9.4	24	71.7	-
24/01/20 to 30/01/20	11.2	24.5	68.2	-

Source: Meteorological Observatory at Bahadari Farm, College of Horticulture, Mandsaur (M.P.)

Fig. 3.1: Weekly meteorological observation during the study period (November, 2019 to January, 2020)



3.3 Experimental materials:

Ten years old uniform trees of Guava (*Psidium guajava* L.) cv. L- 49 were selected for the study at *Instructional cum Research Fruit Orchard*, Department of Fruit Science, K.N.K. College of Horticulture, Mandsaur (MP).

3.4 Experimental detail and layout:

An experiment on pre- harvest spray of Calcium Chloride and Ascorbic acid along with bagging with Yellow polyethylene and Brown paper of guava fruits comprised of 21 treatments included control. The details of experiment are given in Table 3.2, details of treatments and treatment combinations are presented in Table 3.3. The plan of layout of experiment is given in Fig. 3.2.

Table- 3.2: Detail of the technical programme

Name of crop	Guava (*Psidium guajava* L.)
Name of variety	L- 49
Number of treatment	21
Number of replication	03
Number of plant (s) per treatment	01
Total number of plants	63
Experimental design	RBD (Randomized Block Design)
Pre-harvest spray	Calcium chloride and Ascorbic acid
Pre-harvest bagging	Brown paper and Yellow polyethylene

Time of spraying :- Single spraying of $CaCl_2$ and Ascorbic acid were done at 30 days before harvesting of the fruits.

Time of bagging :- Bagging of fruits with Yellow polyethylene bags and Brown paper bags were done one month before harvesting of the fruits.

Table- 3.3: Detail of the treatments:

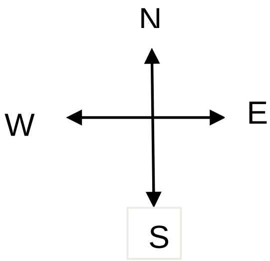
Symbol	Treatments and treatment combinations
T_0	Control
T_1	$CaCl_2$ @ 1%
T_2	$CaCl_2$ @ 1.5%
T_3	$CaCl_2$ @ 2%
T_4	Ascorbic acid @ 200ppm
T_5	Ascorbic acid @ 300 ppm
T_6	Ascorbic acid @ 400 ppm
T_7	Bagging with Brown paper
T_8	Bagging with Yellow polyethylene
T_9	$CaCl_2$ @ 1% with Brown paper
T_{10}	$CaCl_2$ @ 1.5% with Brown paper
T_{11}	$CaCl_2$ @ 2% with Brown paper
T_{12}	Ascorbic acid @ 200 ppm with Brown paper
T_{13}	Ascorbic acid @ 300 ppm with Brown paper
T_{14}	Ascorbic acid @ 400 ppm with Brown paper
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene

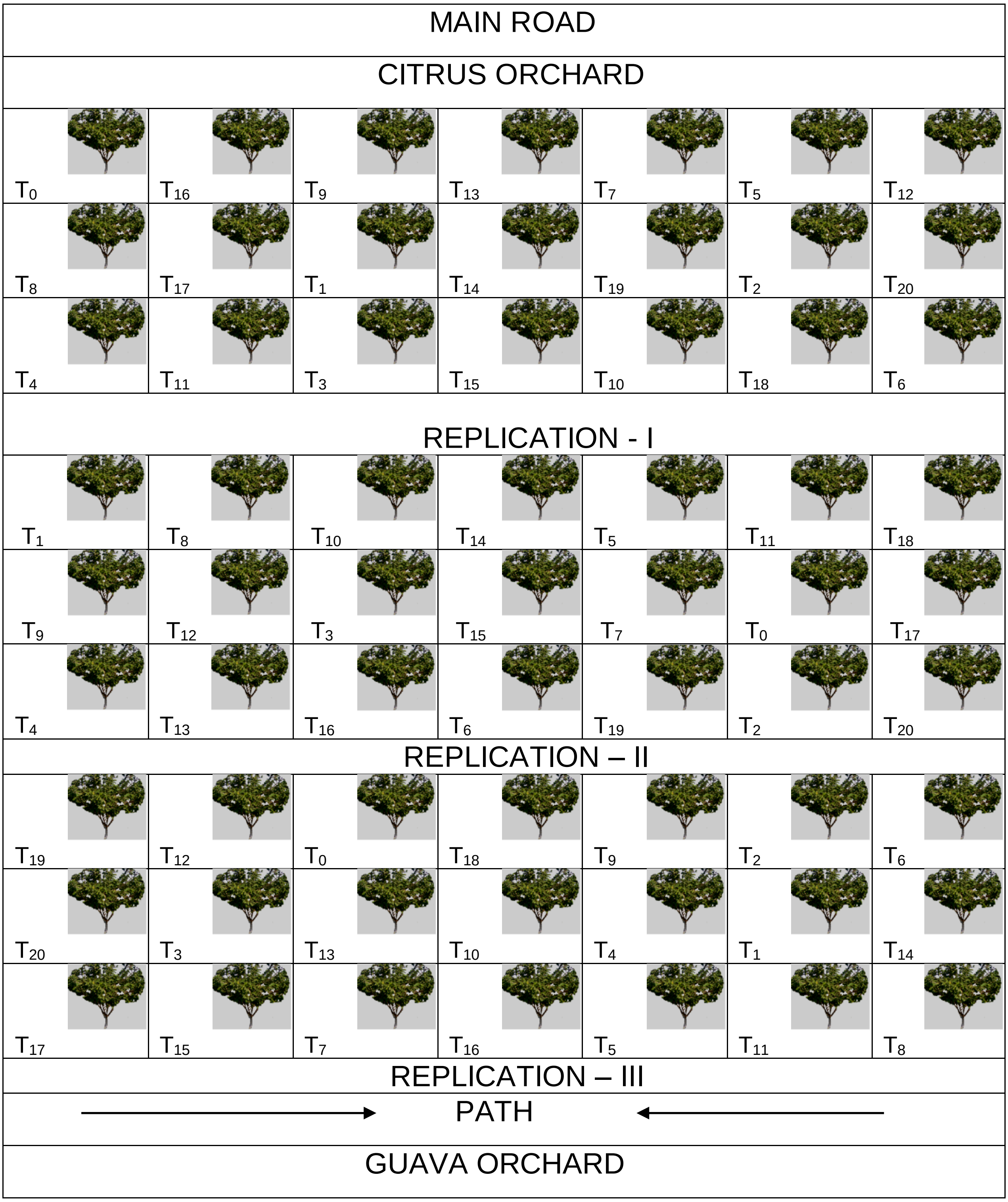
Plate No. 3.1- Pre-harvest spraying of $CaCl_2$ and Ascorbic acid

Plate No. 3.2- Pre-harvest bagging of guava fruits with Brown paper

Plate No. 3.3- Pre-harvest bagging of guava fruits with yellow polyethylene

Fig. 3.2 Layout of the trial:





3.5 Observations:

Observations on various physical parameters, bio-chemical characteristics and organoleptic tests of guava cv. L- 49 under different treatment applications were recorded as per the methods given under different parameter:

(A) Physical parameters:

1. Fruit length (cm)
2. Fruit width (cm)
3. Fruit weight (g)
4. Fruit volume (ml)
5. Specific gravity
6. Pulp weight (g)

(B) Biochemical parameters:

1. Total Soluble Solids (^{0}B)
2. Acidity (%)
3. TSS : acidity ratio
4. Ascorbic acid content (mg/100g pulp)
5. Pectin content (%)
6. pH
7. Chlorophyll content in leaves (SPAD)

(C) Organoleptic test:

1. Fruit taste
2. Fruit colour
3. Fruit texture
4. Fruit aroma

3.5.1 Physical parameters of fruits:

Three fruits from each replication of treatments were randomly selected and tagged for recording physical parameters.

3.5.1.1 Fruit length (cm):

The length of fruits was measured at harvest with the help of digital Vernier callipers and the value is expressed in centimeters.

3.5.1.2 Fruit width (cm):

The width of the fruits was measured from the centre of the fruits with the help of digital Vernier callipers and expressed in centimeters.

3.5.1.3 Fruit weight (g):

Randomly three fruits were selected from each replication of the treatment. Fruits were weighed with the help of electronic balance and average fruit weight was calculated and it is expressed in gram (g).

3.5.1.4 Fruit volume (ml):

The volume of fruit was recorded by water displacement method with the help of measuring cylinder and expressed in milliliters.

3.5.1.5 Specific gravity:

The specific gravity was obtained by dividing the weight of the fruit by volume of the fruit.

Specific gravity = weight of fruits (g)/ volume of fruits (ml)

3.5.1.6 Pulp weight (g):

To calculate pulp weight of 3 randomly selected fruit was calculated by the following formula. Obtained value was expressed in gram.

Pulp weight = fruit weight – seed weight

3.5.2 Bio-Chemical parameters of fruit:

For determination of fruit quality, three fruits were selected from each replication of treatments for analysis of the following contents.

3.5.2.1 Total Soluble Solids (^{0}Brix):

For estimation of TSS, fruits were crushed to form a homogenized sample and then the juice was extracted through muslin cloth. The extract was used for determination of TSS in ^{0}B with the help of digital refractometer. A few drops of juice were placed on the surface of prism. The hinged part was placed back. The refractometer was then placed against the sun, and the reading was noted by revolving the eyepiece at room temperature (A.O.A.C., 1980).

3.5.2.2 Acidity (%):

An estimation of acidity was followed by the method of Ranganna (2013). Small amount of fruits were crushed well to homogenized and 5g was taken out in a 20 ml beaker. The volume was made up to 50 ml with distilled water. Shake well and filter. Take 2 ml from filter in a conical flask and add few drop of phenolphthalein indicator. The solution was titrated against 0.1N NaOH and the titer value was recorded. The NaOH was standardized by titration against 10 ml of 0.1N oxalic acid.

$$\text{Acidity (\%)} = \frac{\text{Titer value x Normality of NaOH x Volume made up x Eq. Wt. of acid x 100}}{\text{Volume of sample taken for estimation x Wt. of sample taken x 1000}}$$

3.5.2.3 TSS : Acidity ratio

Value of Total Soluble Solids was divided by acidity percent to obtain TSS: acidity ratio.

3.5.2.4 Ascorbic acid content (mg/100g):

Assay method was followed as given by Rangana (2013).

(a) Preparation of 3 percent Meta phosphoric acid (HPO_3)

For preparing the 3% Meta phosphoric acid (HPO_3) solution, dissolve the 3 g sticks or pellets of HPO_3 in distilled water.

(b) Ascorbic acid standard

100 mg of ascorbic acid was weighed and made up to 100 ml with 3% (HPO_3). One ml of this solution was diluted to 10 ml by adding 3% HPO_3 (1 ml = 0.1 mg ascorbic acid).

(c) Dye solution

52 mg of dye of 2,6-dichlorophenolindophenol was dissolved in 150 ml of hot distilled water containing 42 mg sodium bicarbonate after cooling, it was diluted with 200ml distilled water and stored in refrigerator and standardized every day.

Standardization of dye

Take 5 ml of standard ascorbic acid solution and 5 ml of HPO_3. Fill a micro burette with dye. Titrate with the dye solution to a pink color, which persisted for 15 sec. Determine the dye factor, i.e. mg of ascorbic acid per ml of the dye, using the formula:

$$\text{Dye factor} = \frac{0.5}{\text{Titer value}}$$

For estimation of a ascorbic acid well homogenized 2 g of sample taken in a beaker and volume was made up to 20 ml and 5 ml of HPO_3 is added and titrated with the standard dye solution to a pink end-point which should persist for 15 seconds. The ascorbic acid content of the sample was calculated by using the following formula:

$$\text{Ascorbic acid} = \frac{\text{Titer value x dye factor x Volume made up x 100}}{\text{Aliquot extract taken for estimation x Wt. of sample taken}}$$

3.5.2.5 Pectin content (%):

Reagents:

Acetic acid: Normal solution: 30ml glacial acetic acid in 500ml water.

Calcium chloride: Normal solution: by adding 55g anhydrous $CaCl_2$ in water, dissolved and diluted to 100ml.

Silver nitrate-1%: By dissolving 5g $AgNO_3$ in water and diluted to 500ml.

Principle: Addition of calcium chloride results in the precipitation of pectin as calcium pectate from an acid solution. Calcium pectate was washed with water to make free from chloride, well dried and weighed.

Procedure: Pectin percent in fresh pulp was estimated by using method as reported by Ranganna (2013).

By taking 25 g of well washed sample in one liter beaker and add 400ml water and boiled for one hour. Replaced the evaporated water by addition of distilled water. Cooled it and transferred to 500ml volumetric flask. It was filtered through Whatman Paper No. 4. Took 100ml of the filtrate in two beakers. Further, added 300ml distilled water to each. Then 10ml 1N NaOH solution was added and kept overnight. 50ml 1N acetic acid also added and waited for 5 minutes. After this $CaCl_2$ solution was added and kept for one hour and same was boiled for one minute. Now by taking two Whatman Paper No. 4 filters washing was done with distilled water and dried in an oven at 100^0C for two hours and then weighed. The solution was filtered through Whatman Paper No. 4 filters. Washing was done with distilled water to make free from chloride ions and a few drops of silver nitrate solution were added and the white precipitate (on filter paper in a petridish) was kept in an oven, dried and weighed again.

Calculation:

$$\text{Pectin (\%)} = \frac{\text{Weight of Ca pectate (g)}}{\text{Weight of sample}} \times 100$$

3.5.2.6 pH :

The pH of fruit was determined by method suggested by Piper (1966) on Glass electrode pH meter in 1:2 (soil: solution ratio)” at 25 °C.

3.5.2.7 Chlorophyll content in leaves (SPAD value):

Chlorophyll content in leaves was estimated by using instrument SPAD chlorophyll meter by simple clamping the meter over leafy tissue and recorded the value.

3.5.3 Organoleptic test:

The guava fresh fruits were subjected to sensory evaluation by a panel of six judges. The fruits were evaluated for fruit taste, colour, texture and aroma was done using Hedonic scale method of Peryam and Pilgrim (1957).

The characters with mean scores of more out of 9 marks were considered acceptable. The marks allotted to fruits of different treatments were calssified into following ranks/categories. Scoring done by following pattern, Table 3.4.

Table- 3.4: Sensory score card for taste, color, texture and aroma of fruits:

S. No.	Category	Marks/Range
1	Excellent	9
2	Very good	7-8
3	Good	5-6
4	Poor	1-4

3.5.3.1 Fruit taste:

Observation was done on the basis of taste of fruits and recorded as per panel members.

3.5.3.2 Fruit colour:

Fruit colour by visual characteristics to record observation. It was observed by the panel members.

3.5.3.3 Fruit texture:

Texture of fruit was estimated by their appearance and recorded the observation as per panel members.

3.5.3.4 Fruit aroma:

Observation for aroma is taken on the basis of smell and recorded as suggested by panel members.

3.6 Statistical analysis:

The Skeleton of ANOVA as per design is given in Table 5. The standard error and critical difference is calculated with the help of following formulas: The significance of the treatment judged by using critical difference (C.D.).

3.6.1 Standard error of mean (S.Em. ±):

(a) S.Em. ± For T = $\sqrt{\frac{EMS}{R}}$

3.6.2 Critical difference (CD):

(a) CD for T = S.Em. ± (T) x √2 x $t_{5\% \text{ (edf)}}$

Where:-

R = Number of Replications

T = Treatments

t = 't' Table value at error degree of freedom

EMS = Error mean sum of square

S. Em. = Standard error of mean

` CD = Critical difference

Table- 3.5: Skeleton of Analysis of Variance

S.V.	D.F.	S.S.	M.S.S.	'F' value (cal.)	'F' value (tab.)
Replication	2	RSS	RMS	RMS/EMS	3.23
Treatment	20	TSS	TMS	TMS/EMS	1.84
Error	40	ESS	EMS		
Total	62				

CHAPTER - IV
RESULTS

An investigation entitled "**Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L-49 Fruits**" was carried out at the *Instructional cum Research Fruit Orchard*, K.N.K. College of Horticulture, Mandsaur, during 2019-20.

The observations recorded on physical, bio-chemical and organoleptic characteristics under this study are given in Tables from 4.1 to 4.9 and in Fig. from 4.1 to 4.12. The Analysis of Variance for these characters is given in appendices I to IV.

4.1 Physical parameters:

The data regarding the effect of pre-harvest treatments and bagging on physical parameters on guava fruits *viz*. length, width, weight, volume, specific gravity, pulp weight are given in Table 4.1 to 4.4 and Fig. 4.1 to 4.5. The Analysis of Variance for the same is given in appendices I.

4.1.1 Fruit length (cm):

Data recorded due to the effect of pre-harvest treatments and bagging is tabulated in Table 4.1 and graphically represented in Fig 4.1.

Data presented in Table 4.1 revealed that fruit length was significantly influenced by pre-harvest treatments and bagging. The maximum (8.25 cm) fruit length was found at harvest with the application of treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) followed by treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 7.67 cm and treatment T_7 (Bagging with Brown paper) 7.58 cm. On the other hand, within single doses of pre-harvest spraying treatment T_3 ($CaCl_2$ @ 2%) was found with better fruit length (7.11 cm) and bagging with brown paper i.e. treatment T_7 fruit length was found (7.58 cm) better than yellow polyethylene i.e. treatment T_8. However, minimum (5.57 cm) fruit length among the treatments was noticed under the treatment T_0 (Control).

4.1.2 Fruit width (cm):

Data collected due to the influence of pre-harvest treatments and bagging depicted in Table 4.1 and represented in Fig. 4.1.

Table. 4.1 reflects that the fruit width was significantly influenced by pre-harvest treatments and bagging at harvest. The maximum fruit width (8.72 cm) was observed under the treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_7 (Bagging with brown paper) 8.10 cm was *at par with* T_{11} ($CaCl_2$ @ 2% with Brown paper) and also treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) followed by treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 7.96 cm and treatment T_{18} (Ascorbic acid @ 200 ppm with Yellow polyethylene). Among single doses fruit width was found higher (7.34 cm) in treatment T_3 ($CaCl_2$ @ 2%) and between the treatments of fruit bagging fruit width was found better in treatment T_7 (Bagging with brown paper) 8.10 cm then the treatment T_8 (Bagging with Yellow polyethylene). However, the least fruit width 5.92 cm was observed in treatment T_0 (Control).

4.1.3 Fruit weight (g):

Data recorded due to the effect of pre-harvest treatments and bagging depicted in Table 4.2 and graphically presented in Fig. 4.2.

The data presented in Table 4.2 revealed that fruit weight was significantly influenced by the spray of pre-harvest treatments and bagging. Maximum fruit weight (199.67 g) was found under the treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_{14} (Ascorbic acid @ 400 ppm with Brown paper) 198.97 g was *at par with* treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_{11} followed by treatments T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 196.78 g and T_9 ($CaCl_2$ @ 1% with Brown paper) 193.67 g. Among the single doses of pre-harvest spraying, treatment T_3 ($CaCl_2$ @ 2%) perform better in fruit weight (154.11 g) while, bagging with brown paper i.e. treatment T_7 proved better (183.00 g) then the yellow polyethylene i.e. treatment T_8. Whereas, the lowest fruit weight 122.67 g was found under treatment T_0 (control).

Table- 4.1: Effect of pre-harvest treatments and bagging on fruit length and width

Treatments		Fruit length (cm)	Fruit width (cm)
T_0	Control	5.57	5.92
T_1	$CaCl_2$ @ 1%	6.60	6.86
T_2	$CaCl_2$ @ 1.5%	6.86	6.87
T_3	$CaCl_2$ @ 2%	7.11	7.34
T_4	Ascorbic acid @ 200ppm	6.36	7.13
T_5	Ascorbic acid @ 300 ppm	6.60	7.30
T_6	Ascorbic acid @ 400 ppm	6.46	7.02
T_7	Bagging with Brown paper	7.58	8.10
T_8	Bagging with Yellow polyethylene	7.27	7.09
T_9	$CaCl_2$ @ 1% with Brown paper	6.58	7.41
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	7.67	7.96
T_{11}	$CaCl_2$ @ 2% with Brown paper	8.25	8.72
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	7.46	7.72
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	7.05	7.78
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	6.98	7.07
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	7.49	7.47
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	7.01	7.10
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	7.54	7.36
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene	7.23	7.79
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene	7.20	7.28
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene	7.47	7.48
	S.Em. ±	**0.12**	**0.21**
	C.D. at 5%	**0.33**	**0.59**

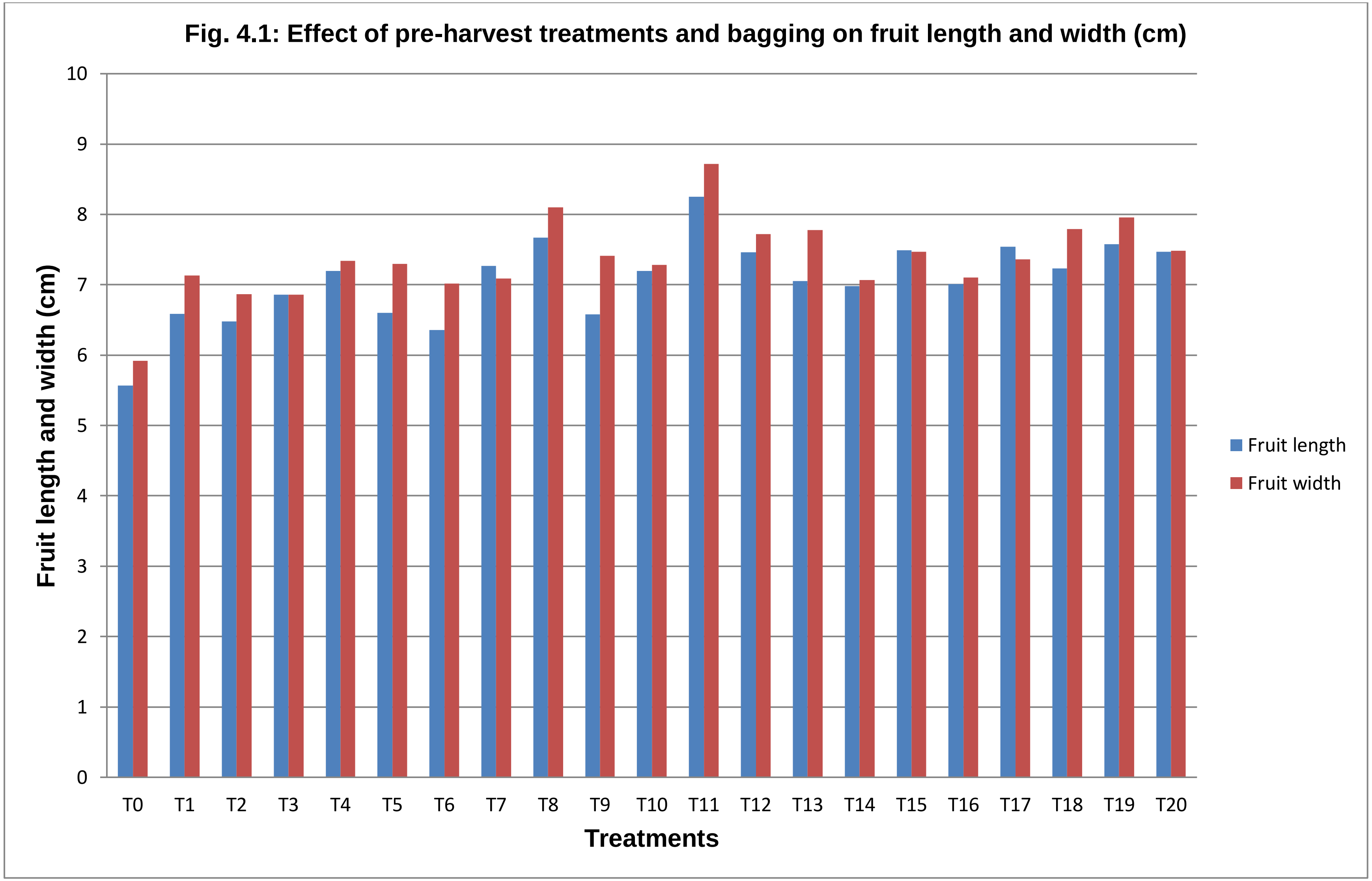


Fig. 4.1: Effect of pre-harvest treatments and bagging on fruit length and width (cm)
Fruit length and width (cm)
0
1
2
3
4
5
6
7
8
9
10
T0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
Treatments
Fruit length
Fruit width

Table- 4.2: Effect of pre-harvest treatments and bagging on fruit weight

Treatments		Fruit weight (g)
T_0	Control	122.67
T_1	$CaCl_2$ @ 1%	152.45
T_2	$CaCl_2$ @ 1.5%	153.89
T_3	$CaCl_2$ @ 2%	154.11
T_4	Ascorbic acid @ 200ppm	132.67
T_5	Ascorbic acid @ 300 ppm	146.63
T_6	Ascorbic acid @ 400 ppm	147.67
T_7	Bagging with Brown paper	183.00
T_8	Bagging with Yellow polyethylene	167.33
T_9	$CaCl_2$ @ 1% with Brown paper	193.67
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	196.78
T_{11}	$CaCl_2$ @ 2% with Brown paper	199.67
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	179.72
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	187.77
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	198.97
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	174.34
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	169.11
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	166.33
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene	177.13
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene	164.33
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene	155.11
	S.Em. ±	**6.07**
	C.D. at 5%	**17.35**

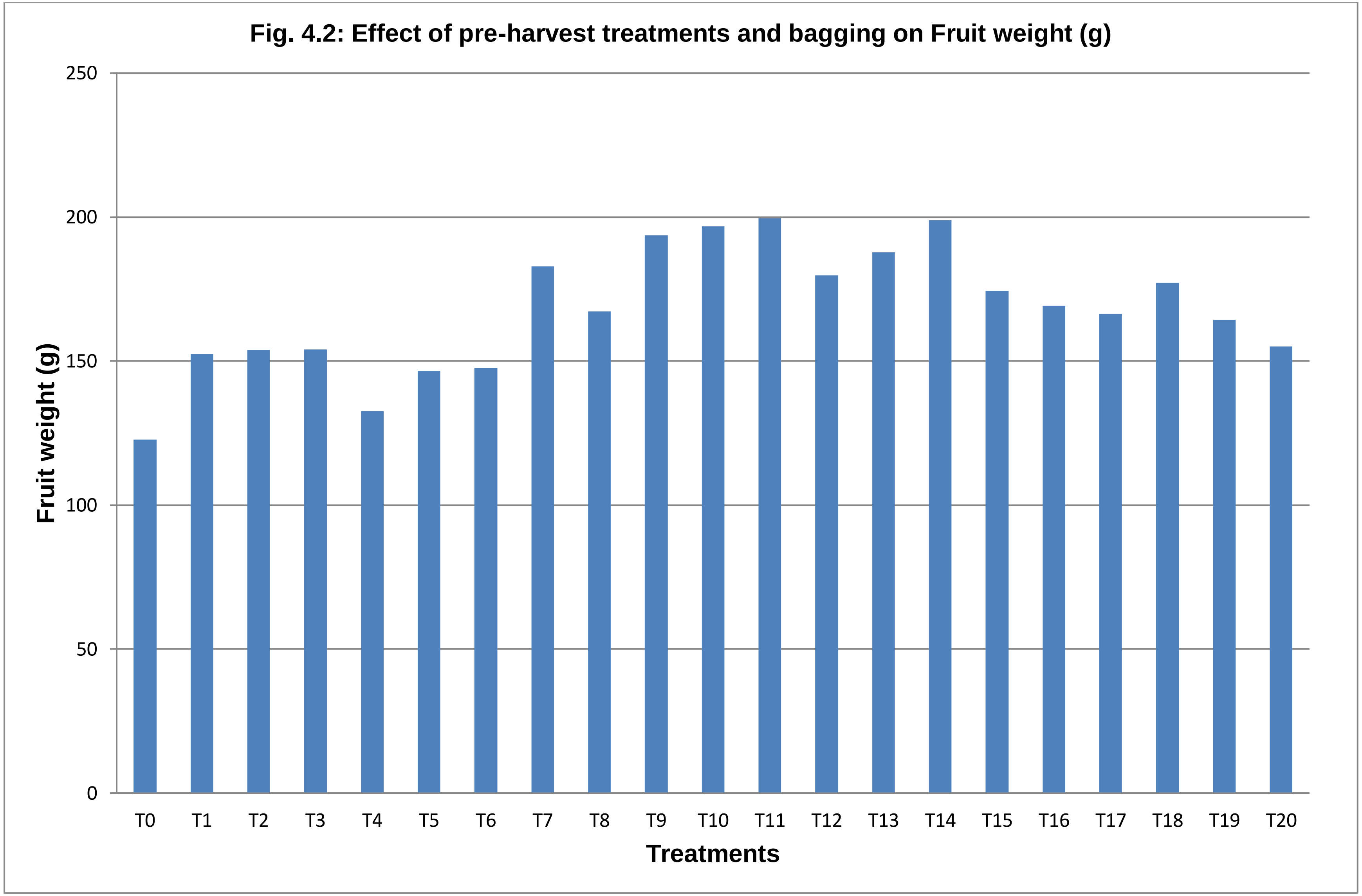


Fig. 4.2: Effect of pre-harvest treatments and bagging on Fruit weight (g)
Fruit weight (g)
250
200
150
100
50
0
T0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
Treatments

4.1.4 Fruit Volume (ml):

The data pertaining to effect of pre-harvest treatments and bagging on the fruit volume are embodied in Table 4.3 and graphically represented in Fig. 4.3.

On observing Table 4.3 the volume of fruit significantly influenced by the pre-harvest spraying and the highest volume (197.67 ml) of fruit was observed with the application of treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_{12} (Ascorbic acid @ 200 ppm with Brown paper) 197.47 ml was *at par with* treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) followed by treatment T_9 ($CaCl_2$ @ 1% with Brown paper) 195.60 ml and treatment T_{14} (Ascorbic acid @ 400 ppm with Brown paper) 185.97 ml. Other than combinations, the single doses of pre-harvest spraying, treatment T_3 ($CaCl_2$ @ 2%) was noticed with higher fruit volume (152.59 ml) and within the bagging, the brown paper i.e. treatment T_7 proved better (174.32 ml) than the yellow polyethylene i.e. treatment T_8. Although, minimum fruit volume (136.30 ml) was observed under the treatment T_0 (Control).

4.1.5 Specific gravity:

The response of pre-harvest treatments and bagging on specific gravity was found statistically non-significant.

Table 4.4 and Fig. 4.4 shows data of specific gravity. Statistically analysed data in Table 4.4 indicated that the data recorded due to the effect of pre-harvest treatments and bagging had no significant influence on specific gravity of fruit. Although the numerically higher value for specific gravity 1.07 was found under the treatment T_2 ($CaCl_2$ @ 1.5%), treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) and treatment T_{14} (Ascorbic acid @ 400 ppm with Brown paper) followed by treatment T_{18} (Ascorbic acid @ 200 ppm with Yellow polyethylene) 1.06 and lower specific gravity 0.90 of fruit was found with the treatment T_0 (Control).

4.1.6 Pulp weight (g):

Data recorded due to the effect of pre-harvest treatments and bagging depicted in Table 4.4 and Fig. 4.5.

Data regarding the pulp weight of fruit was significantly influenced by pre-harvest treatments and bagging as shown in Table 4.4. The highest pulp weight (173.40 g) was observed with the treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 156.67 g and treatment T_9 ($CaCl_2$ @ 1% with Brown paper) 146.44 g followed the treatment $T_{11.}$ However, within single doses of pre-harvest spraying, greater pulp weight (110.67 g) in treatment T_3 ($CaCl_2$ @ 2%) and between the bagging the maximum amount of pulp weight (118.58 g) was noticed in treatment T_7 (Bagging with brown paper) over the treatment T_8. While, the lowest amount of pulp weight (92.00 g) was observed under the treatment T_0 (Control).

4.2 Bio-Chemical parameters:

Present study of pre-harvest treatments and bagging have considerable enhancement on the biochemical parameters of guava and the data regarding this is given in Tables 4.5 to 4.8 and diagrammatically represented in Fig. 4.6 to 4.12. The Analysis of Variance for the same is given in the appendices II and III. The observations on the bio-chemical characteristics *viz*. TSS, acidity, TSS: acidity ratio, ascorbic acid content, pectin content, pH and chlorophyll content in leaves was found at the harvest and the data of the table are illustrated below:

4.2.1 Total Soluble Solids (TSS) ^{0}Brix:

Analysed data recorded due to the effect of pre-harvest treatments and bagging was depicted in Table 4.5 and graphically structured in Fig. 4.6. TSS of guava was significantly influenced by applying pre-harvest treatments and bagging as compared to control. The highest TSS (Total Soluble Solids) value 11.50 ^{0}Brix noticed with the application of treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) followed by treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 10.62 ^{0}Brix and treatment T_{16} ($CaCl_2$ @ 1.5% with Yellow polyethylene) 10.50 ^{0}Brix. In single doses, higher TSS was found in T_3 over rest of the doses, treatment T_3 ($CaCl_2$ @ 2%) was found better TSS 10.62 ^{0}Brix and between the treatments of bagging maximum TSS (10.33 ^{0}Brix) was noticed under the treatment T_7 (Bagging with brown paper). The lowest TSS (8.61 ^{0}Brix) was registered under treatment T_0 (Control).

Table- 4.3: Effect of pre-harvest treatments and bagging on fruit volume

Treatments		Fruit volume (ml)
T_0	Control	136.30
T_1	$CaCl_2$ @ 1%	162.16
T_2	$CaCl_2$ @ 1.5%	143.93
T_3	$CaCl_2$ @ 2%	152.59
T_4	Ascorbic acid @ 200ppm	147.40
T_5	Ascorbic acid @ 300 ppm	143.73
T_6	Ascorbic acid @ 400 ppm	140.63
T_7	Bagging with Brown paper	174.32
T_8	Bagging with Yellow polyethylene	159.37
T_9	$CaCl_2$ @ 1% with Brown paper	195.60
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	183.90
T_{11}	$CaCl_2$ @ 2% with Brown paper	197.67
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	197.47
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	184.00
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	185.97
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	170.90
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	162.66
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	159.93
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene	167.10
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene	162.76
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene	165.00
	S.Em. ±	**0.79**
	C.D. at 5%	**2.27**

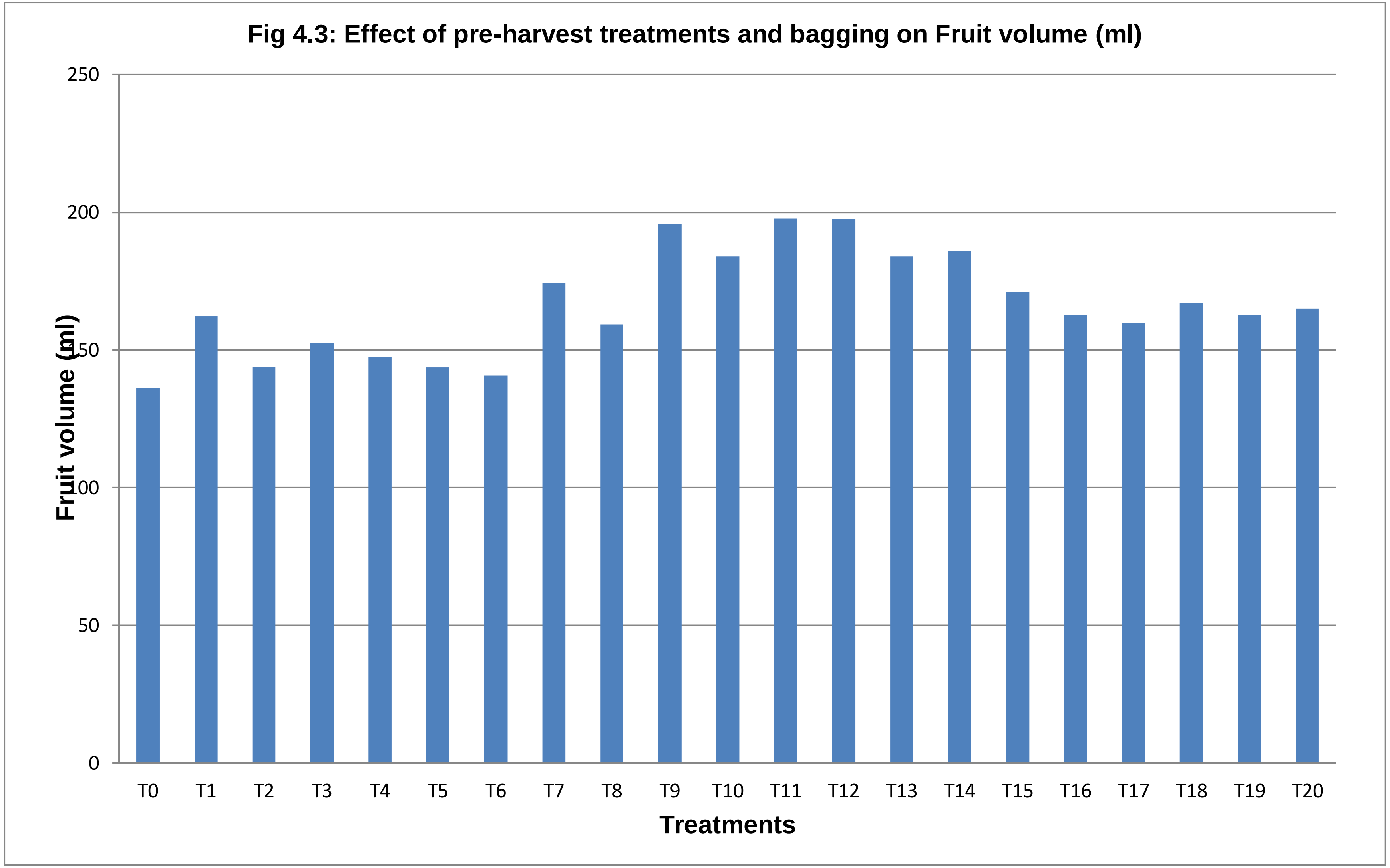


Fig 4.3: Effect of pre-harvest treatments and bagging on Fruit volume (ml)
Fruit volume (ml)
250
200
150
100
50
0
T0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
Treatments

Table- 4.4: Effect of pre-harvest treatments and bagging on specific gravity and pulp weight

Treatments		Specific gravity	Pulp weight (g)
T_0	Control	0.90	99.83
T_1	$CaCl_2$ @ 1%	0.94	105.22
T_2	$CaCl_2$ @ 1.5%	1.07	109.56
T_3	$CaCl_2$ @ 2%	1.05	110.67
T_4	Ascorbic acid @ 200ppm	1.04	100.20
T_5	Ascorbic acid @ 300 ppm	0.91	103.23
T_6	Ascorbic acid @ 400 ppm	1.05	103.33
T_7	Bagging with Brown paper	1.05	118.58
T_8	Bagging with Yellow polyethylene	1.05	117.00
T_9	$CaCl_2$ @ 1% with Brown paper	0.99	146.44
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	1.07	156.67
T_{11}	$CaCl_2$ @ 2% with Brown paper	1.05	173.40
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	0.91	133.22
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	1.02	134.24
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	1.07	141.34
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	1.02	112.11
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	1.04	114.89
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	1.04	115.40
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene	1.06	118.00
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene	1.01	142.22
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene	0.94	119.67
	S.Em. ±	**0.02**	**6.96**
	C.D. at 5%	**0.07**	**19.90**

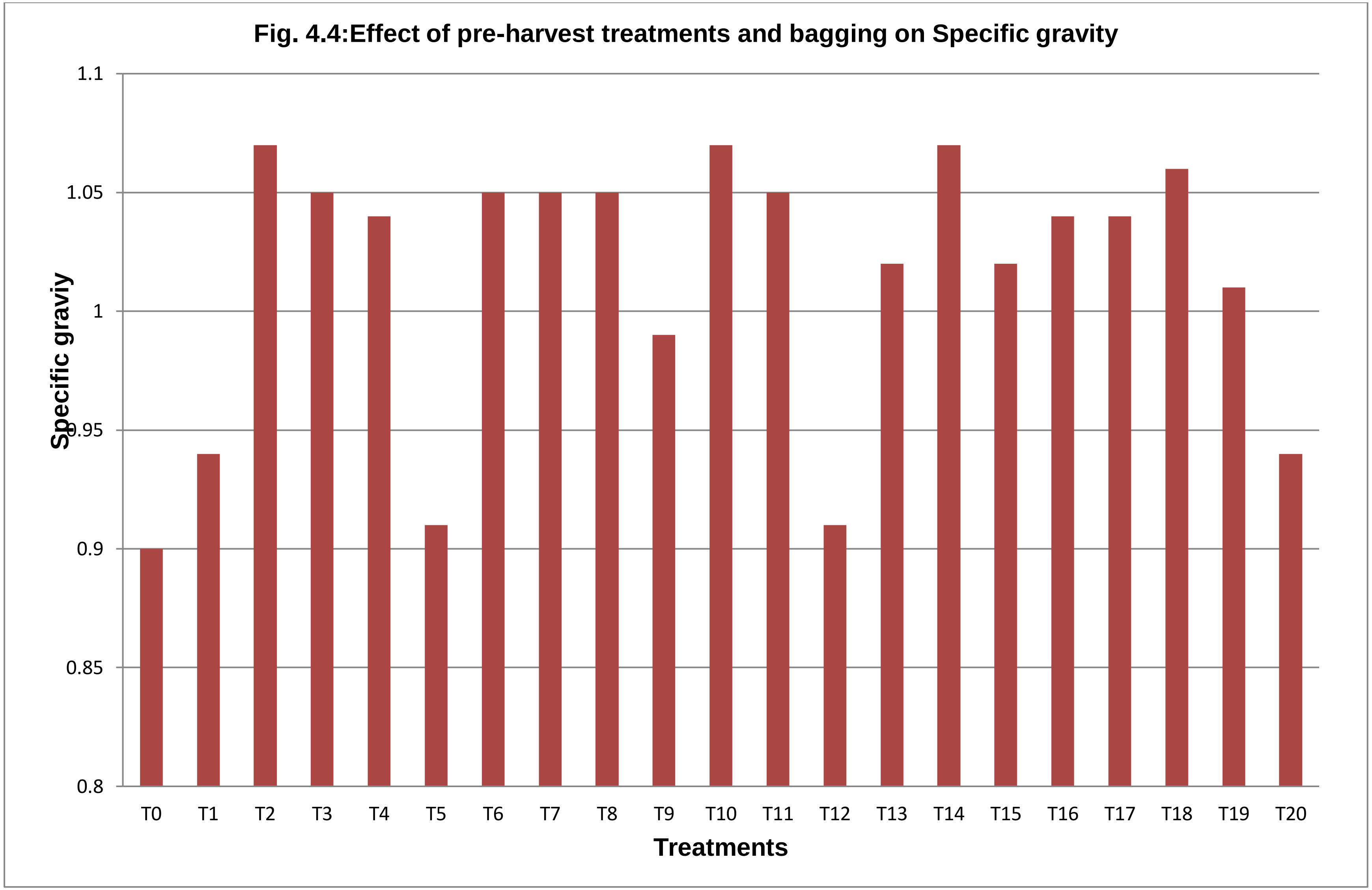


Fig. 4.4:Effect of pre-harvest treatments and bagging on Specific gravity
Specific graviy
1.1
1.05
1
0.95
0.9
0.85
0.8
T0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
Treatments

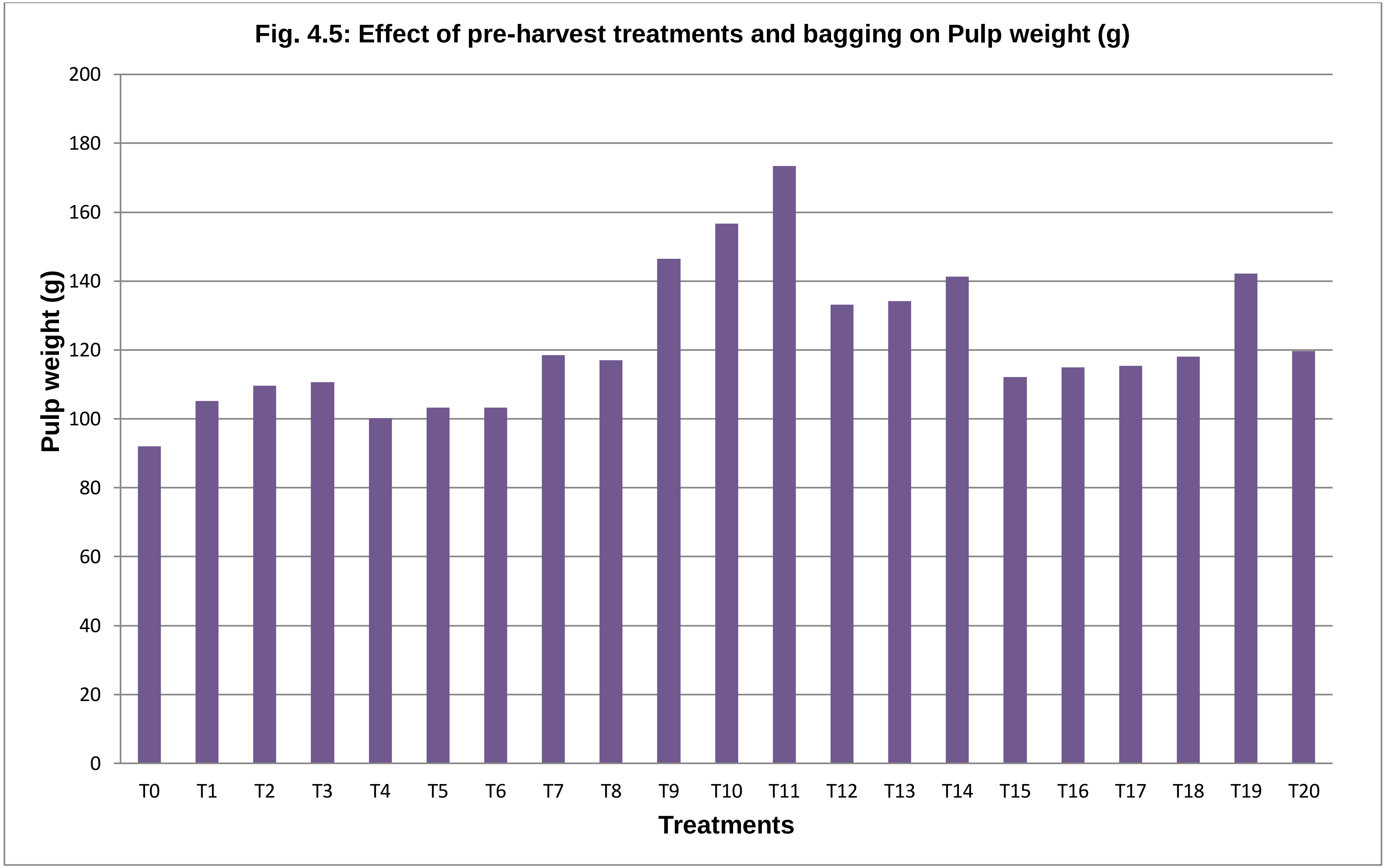
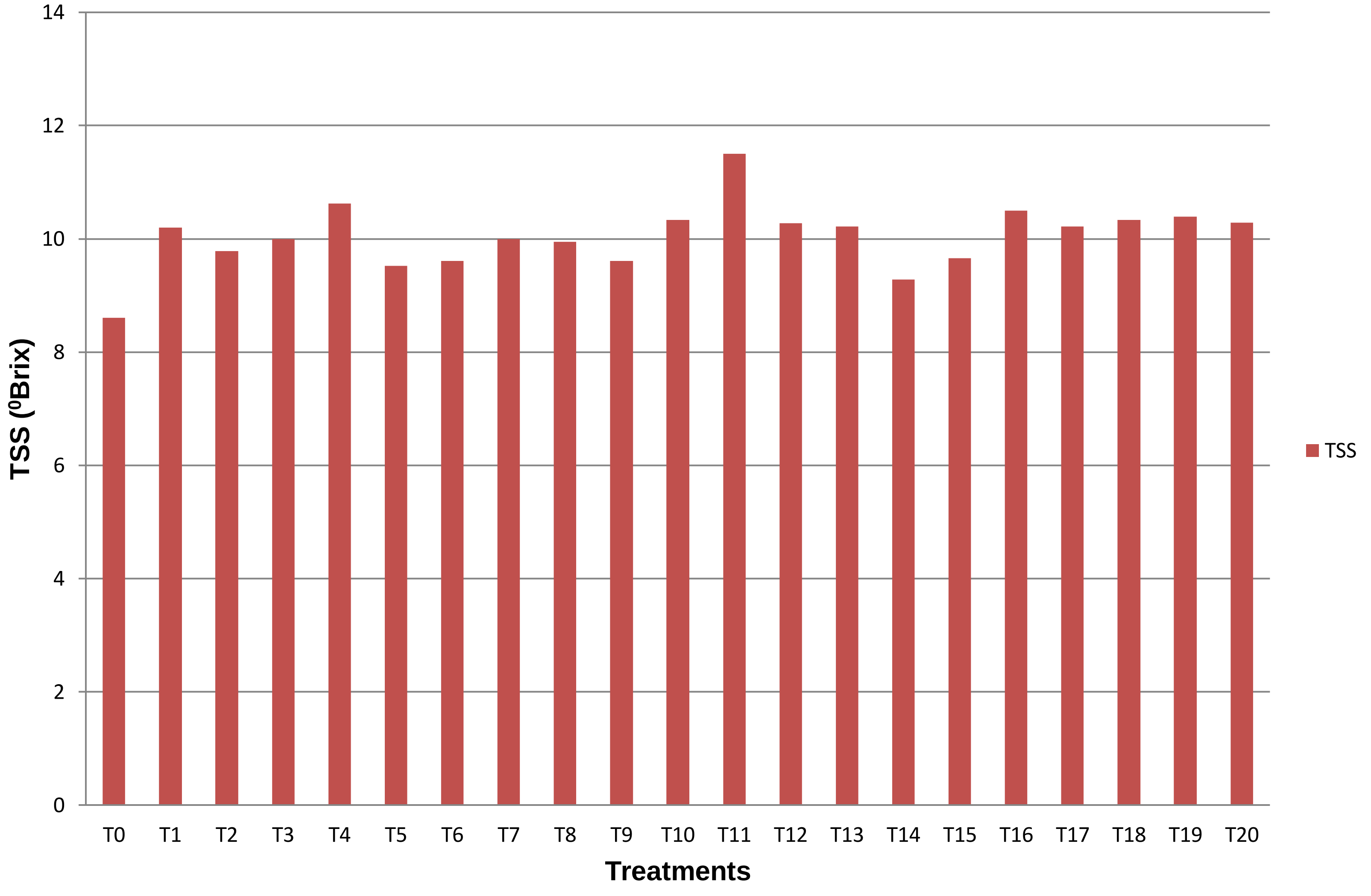


Fig. 4.5: Effect of pre-harvest treatments and bagging on Pulp weight (g)
Pulp weight (g)
0
20
40
60
80
100
120
140
160
180
200
T0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
Treatments

Table- 4.5: Effect of pre-harvest treatments and bagging on TSS

Treatments		TSS (^{0}B)
T_0	Control	8.61
T_1	$CaCl_2$ @ 1%	9.53
T_2	$CaCl_2$ @ 1.5%	9.53
T_3	$CaCl_2$ @ 2%	10.62
T_4	Ascorbic acid @ 200ppm	9.78
T_5	Ascorbic acid @ 300 ppm	8.69
T_6	Ascorbic acid @ 400 ppm	9.61
T_7	Bagging with Brown paper	10.33
T_8	Bagging with Yellow polyethylene	10.00
T_9	$CaCl_2$ @ 1% with Brown paper	10.39
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	10.29
T_{11}	$CaCl_2$ @ 2% with Brown paper	11.50
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	10.28
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	10.22
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	9.28
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	9.66
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	10.50
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	10.22
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene	9.62
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene	9.61
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene	9.70
	S.Em. ±	**0.24**
	C.D. at 5%	**0.68**

Fig. 4.6: Effect of pre-harvest treatments and bagging on TSS (^{0}Brix)



4.2.2 Acidity (%):

The data pertaining to the effect of pre-harvest treatments and bagging on the acidity are presented in Table 4.6 and Fig. 4.7.

The pre-harvest treatments and bagging significantly influenced the acidity of guava fruits (Table 4.6) in comparison to the control although among all the treatments lowest acidity (0.33%) was recorded in treatment T_9 ($CaCl_2$ @ 1% with Brown paper) and the highest acidity (0.57%) was observed in the treatment T_0 (Control). Bagging wise treatment T_7 (Bagging with Brown paper) registered minimum acidity then the treatment T8 (Bagging with Yellow polyethylene).

4.2.3 TSS: acidity ratio:

The data recorded due to the response of pre-harvest treatments and bagging on TSS: acidity ratio are presented in Table 4.6 and Fig. 4.8.

Table 4.6 flashed that TSS: acidity ratio was significantly influenced by pre-harvest treatments and bagging. The minimum TSS: acidity ratio (15.22) was noticed under treatment T_0 (Control) and maximum TSS: acidity ratio (26.63) was found with treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_{16} ($CaCl_2$ @ 1.5% with Yellow polyethylene) 26.47 and T_{13} (Ascorbic acid @ 300 ppm with Brown paper) 26.33 were *at par with* treatment T_{11}. Treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 25.84 followed treatment T_{11}. Within single doses of pre-harvest spraying minimum (19.20) and maximum (24.35) TSS: acidity ratio was found in treatments T_4 (Ascorbic acid @ 200 ppm) and T_3 ($CaCl_2$ @ 2%) respectively. Between baggings treatment T_7 (Bagging with brown paper) has much higher TSS: acidity ratio (21.43) then treatment T_8.

Table- 4.6: Effect of pre-harvest treatments and bagging on TSS, Acidity and TSS: acidity ratio

Treatments		Acidity	TSS: acidity ratio
T_0	Control	0.57	15.22
T_1	$CaCl_2$ @ 1%	0.40	17.67
T_2	$CaCl_2$ @ 1.5%	0.43	21.55
T_3	$CaCl_2$ @ 2%	0.47	24.35
T_4	Ascorbic acid @ 200ppm	0.45	19.20
T_5	Ascorbic acid @ 300 ppm	0.43	19.74
T_6	Ascorbic acid @ 400 ppm	0.44	21.07
T_7	Bagging with Brown paper	0.46	21.43
T_8	Bagging with Yellow polyethylene	0.49	20.49
T_9	$CaCl_2$ @ 1% with Brown paper	0.33	22.47
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	0.43	25.84
T_{11}	$CaCl_2$ @ 2% with Brown paper	0.47	26.63
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	0.47	20.77
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	0.46	26.33
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	0.43	24.78
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	0.48	23.79
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	0.41	26.23
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	0.37	26.47
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene	0.41	23.72
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene	0.41	23.53
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene	0.41	24.55
	S.Em. ±	**0.02**	**0.89**
	C.D. at 5%	**0.06**	**2.54**

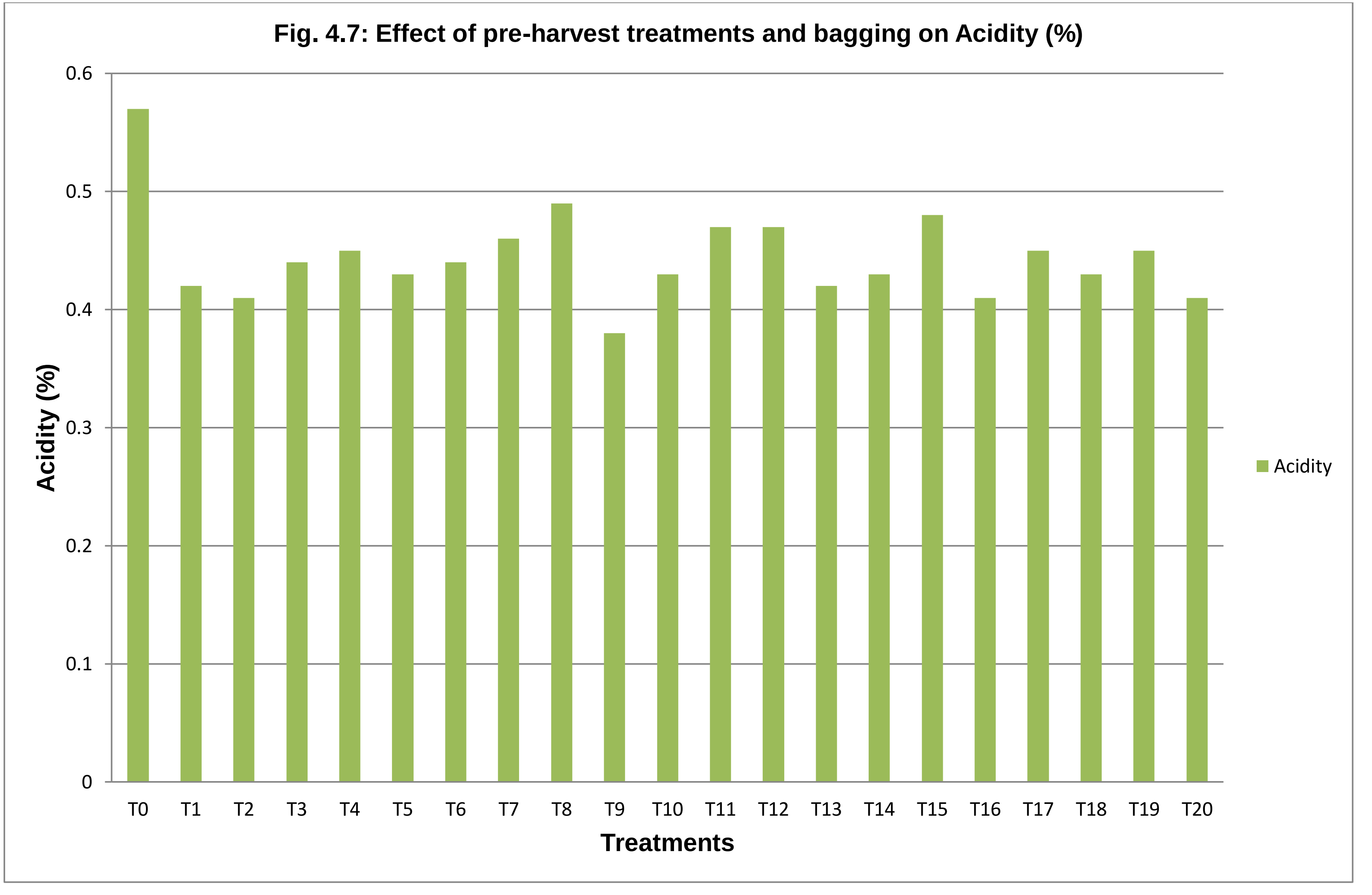


Fig. 4.7: Effect of pre-harvest treatments and bagging on Acidity (%)
0.6
0.5
0.4
0.3
0.2
0.1
0
Acidity (%)
T0 T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 T13 T14 T15 T16 T17 T18 T19 T20
Treatments
Acidity

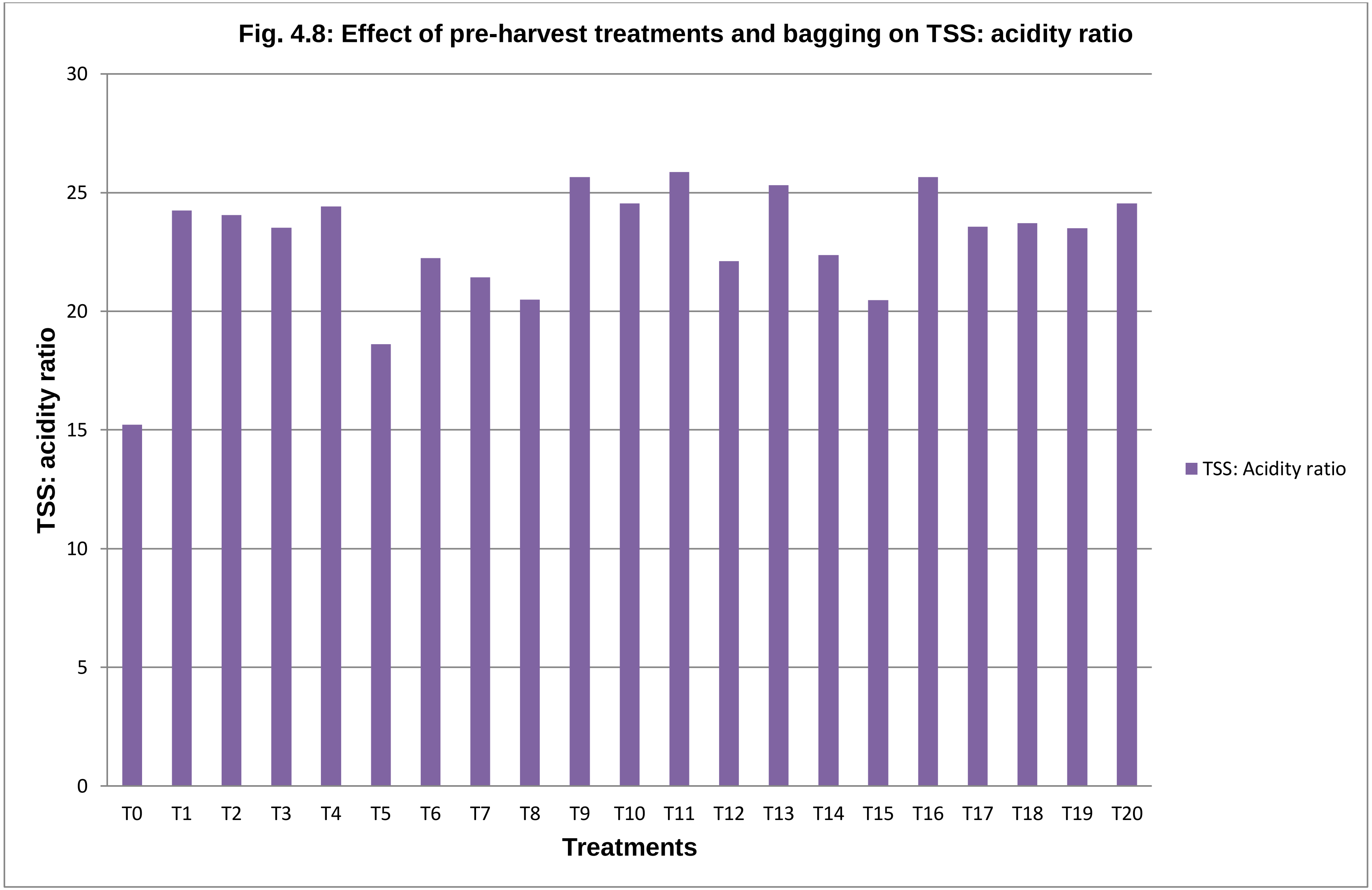


Fig. 4.8: Effect of pre-harvest treatments and bagging on TSS: acidity ratio
TSS: acidity ratio
30
25
20
15
10
5
0
T0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
Treatments
TSS: Acidity ratio

4.2.4 Ascorbic acid content (mg/100g):

Data collected due to the effect of pre-harvest treatments and bagging on the ascorbic acid content is presented in Table 4.7 and Fig. 4.9.

Data associated with ascorbic acid content, presented in Table 4.7 revealed that ascorbic acid content was significantly influenced by pre-harvest spraying and bagging. The maximum amount of ascorbic acid content (192.39 mg) was found with treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) treatment T_7 (Bagging with brown paper) 191.45 mg was *at par with* treatment T_{11}. Treatment T_{13} (Ascorbic acid @ 300 ppm with Brown paper) 185.03 mg and treatment T_{17} ($CaCl_2$ @ 1.5% with Yellow polyethylene) 188.16 mg followed the treatment T_{11}. Among single doses of pre-harvest spraying, maximum ascorbic acid content (168.30 mg) was found in treatment T_3 ($CaCl_2$ @ 2%) and within the bagging maximum ascorbic acid content (191.45 mg) was found in treatment T_7 (Bagging with Brown paper) then yellow polyethylene i.e. treatment T_8. However, the minimum amount of ascorbic acid content (149.33 mg) was found in treatment T_0 (Control).

4.2.5 Pectin content (%):

The data pertaining to effect of pre-harvest treatments and bagging on the ascorbic acid is depicted in Table 4.7 and graphically presented in Fig. 4.10.

Table 4.7 revealed that pectin content was significantly influenced by pre-harvest treatments and bagging. The highest pectin content (1.05%) was noticed with the treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_{15} ($CaCl_2$ @ 1% with Yellow polyethylene) 1.03% and treatment T_7 (Bagging with brown paper) 1.02% were *at par with* treatment T_{11}. Treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 0.99% and treatment T_9 ($CaCl_2$ @ 1% with Brown paper) 0.99% followed the treatment T_{11}. Other than combination, the single doses of pre-harvest spraying, treatment T_3 ($CaCl_2$ @ 2%) has greater of pectin content (0.93%) and bagging wise highest pectin content (1.02%) was found in treatment T_7 (Bagging with Brown paper) over the treatment T_8. Although, the least pectin content (0.76 %) was noticed under treatment T_0 (Control).

Table- 4.7: Effect of pre-harvest treatments and bagging on ascorbic acid content and pectin content

Treatments		Ascorbic acid (mg/100g pulp)	Pectin (%)
T_0	Control	149.33	0.76
T_1	$CaCl_2$ @ 1%	157.22	0.82
T_2	$CaCl_2$ @ 1.5%	164.04	0.91
T_3	$CaCl_2$ @ 2%	168.30	0.93
T_4	Ascorbic acid @ 200ppm	148.57	0.78
T_5	Ascorbic acid @ 300 ppm	146.53	0.85
T_6	Ascorbic acid @ 400 ppm	154.05	0.85
T_7	Bagging with Brown paper	191.45	1.02
T_8	Bagging with Yellow polyethylene	183.84	0.97
T_9	$CaCl_2$ @ 1% with Brown paper	166.85	0.99
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	187.74	0.99
T_{11}	$CaCl_2$ @ 2% with Brown paper	192.39	1.05
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	182.76	0.99
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	188.28	0.92
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	159.00	0.97
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	154.75	1.03
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	180.13	0.91
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	188.16	0.97
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene	172.59	0.95
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene	163.63	0.93
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene	162.79	0.92
	S.Em. ±	**3.31**	**0.03**
	C.D. at 5%	**9.47**	**0.08**

Fig. 4.9: Effect of pre-harvest treatments and bagging on ascorbic acid content (mg/ 100g pulp)

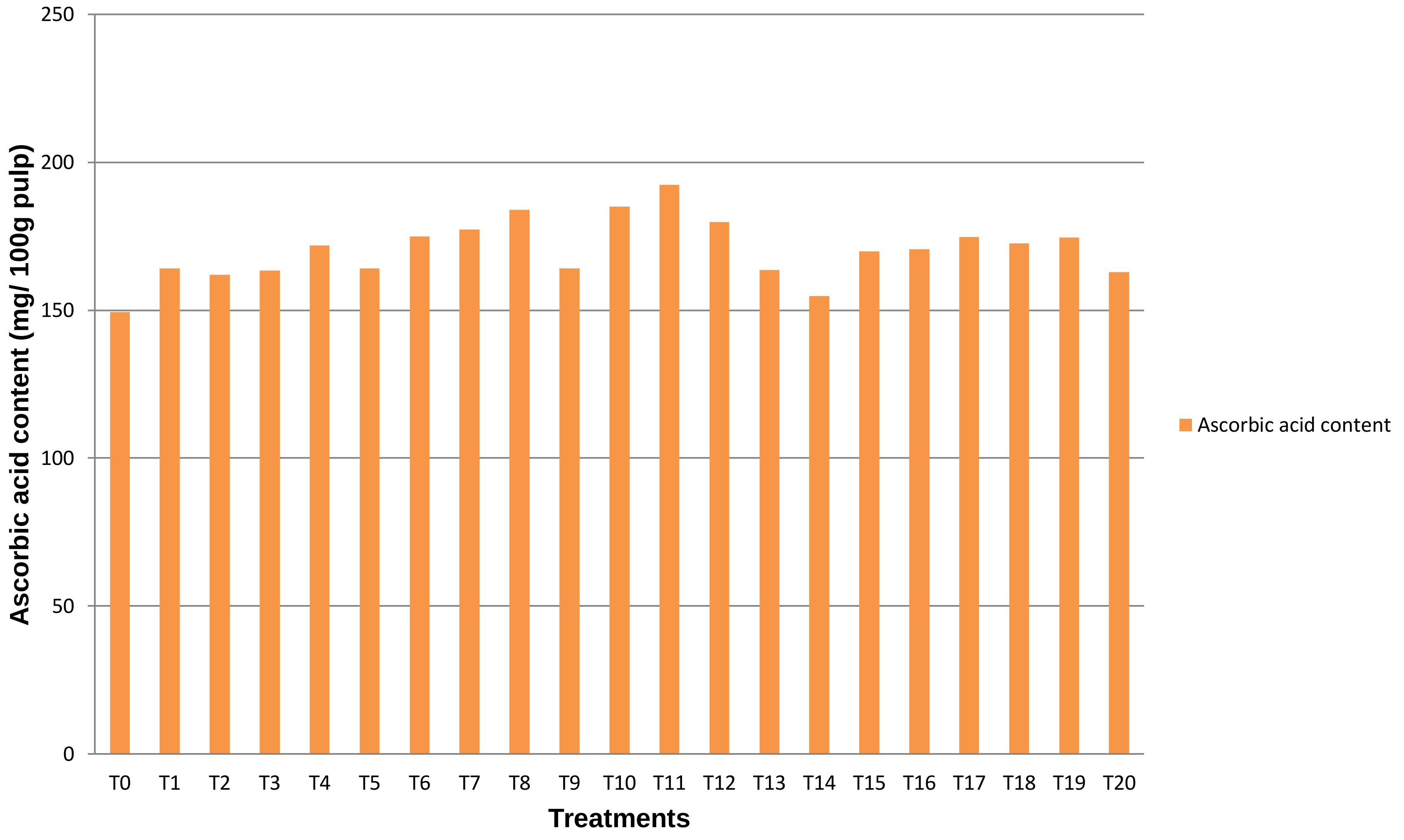
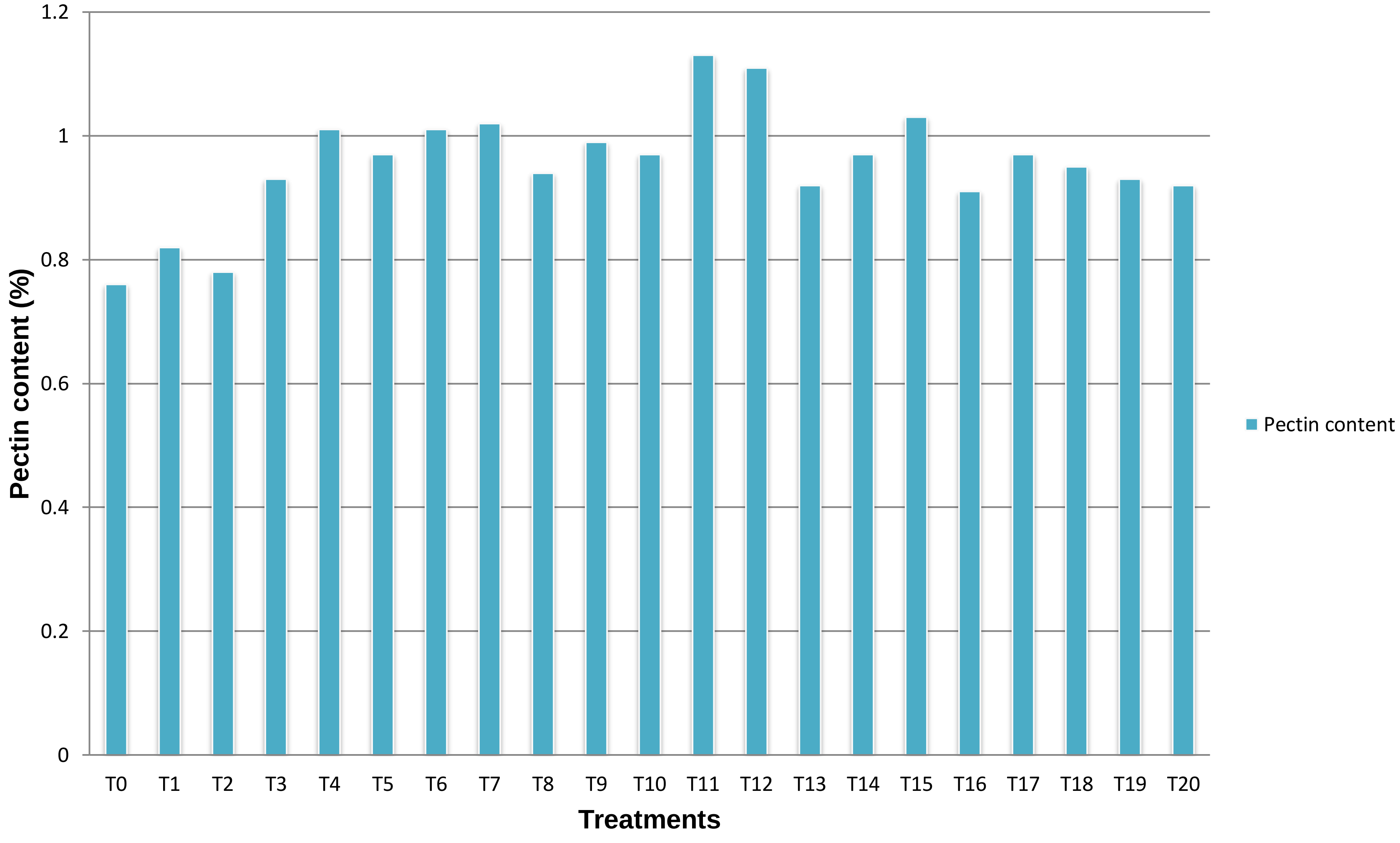


Fig. 4.10: Effect of pre-harvest treatments and bagging on pectin content (%)



4.2.6 pH:

Data embodied in Table 4.8 and represented in Fig. 4.11 was collected due to effect of pre-harvest treatments and bagging.

Data in Table 4.8 shows that pH was significantly influenced by the treatments applied. The maximum pH value (4.73) was observed with the application of treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_{12} (Ascorbic acid @ 200 ppm with Brown paper) 4.38 was *at par with* treatment T_{11} and it is also followed by treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 4.15. Other than this, within single doses of pre-harvest spraying, maximum pH (4.04) was found in treatment T_3 ($CaCl_2$ @ 2%) over the single doses and bagging wise, brown paper i.e. treatment T_7 had maximum pH value (4.07) than yellow polyethylene i.e. treatment T_8. The minimum pH value (3.55) was observed under treatment T_0 (Control).

4.2.7 Chlorophyll content in leaves (SPAD value):

Data tabulated in Table 4.8 and represented graphically in Fig. 4.12 was due to effect of pre-harvest treatments and bagging.

Chlorophyll content in leaves was significantly influenced by the pre-harvest treatments applied. The maximum chlorophyll content (SPAD value) in leaves (46.10) was observed with the application of treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). Treatment T_9 ($CaCl_2$ @ 1% with Brown paper) 44.47 was *at par with* treatment T_{11} and which is followed by treatment T_7 (Bagging with Brown paper) 41.33 along with treatment T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 41.27. Whereas, among the treatments of single doses, pre-harvest spray, highest chlorophyll content (39.77) was recorded in treatment T_3 ($CaCl_2$ @ 2%) and bagging wise maximum chlorophyll content (41.33) recorded in treatment T_7 (Bagging with Brown paper) then yellow polyethylene i.e. treatment T_8. However, the lowest chlorophyll content (30.20) was recorded under treatment T_0 (Control).

Table- 4.8: Effect of pre-harvest treatments and bagging on pH and chlorophyll content in leaves (SPAD value)

Treatments		pH	Chlorophyll
T_0	Control	3.55	30.20
T_1	$CaCl_2$ @ 1%	3.92	39.20
T_2	$CaCl_2$ @ 1.5%	4.01	39.57
T_3	$CaCl_2$ @ 2%	4.04	39.77
T_4	Ascorbic acid @ 200ppm	3.79	37.90
T_5	Ascorbic acid @ 300 ppm	4.01	36.57
T_6	Ascorbic acid @ 400 ppm	4.05	39.03
T_7	Bagging with Brown paper	4.07	41.33
T_8	Bagging with Yellow polyethylene	3.88	39.13
T_9	$CaCl_2$ @ 1% with Brown paper	4.10	44.47
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	4.15	41.27
T_{11}	$CaCl_2$ @ 2% with Brown paper	4.73	46.10
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	4.38	35.50
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	3.88	35.17
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	4.05	37.03
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	4.05	33.50
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	4.07	36.70
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	4.11	36.13
T_{18}	Ascorbic acid @ 200 ppm with Yellow polyethylene	4.00	38.27
T_{19}	Ascorbic acid @ 300 ppm with Yellow polyethylene	4.12	36.17
T_{20}	Ascorbic acid @ 400 ppm with Yellow polyethylene	4.07	35.97
	S.Em. ±	**0.08**	**0.67**
	C.D. at 5%	**0.23**	**1.91**

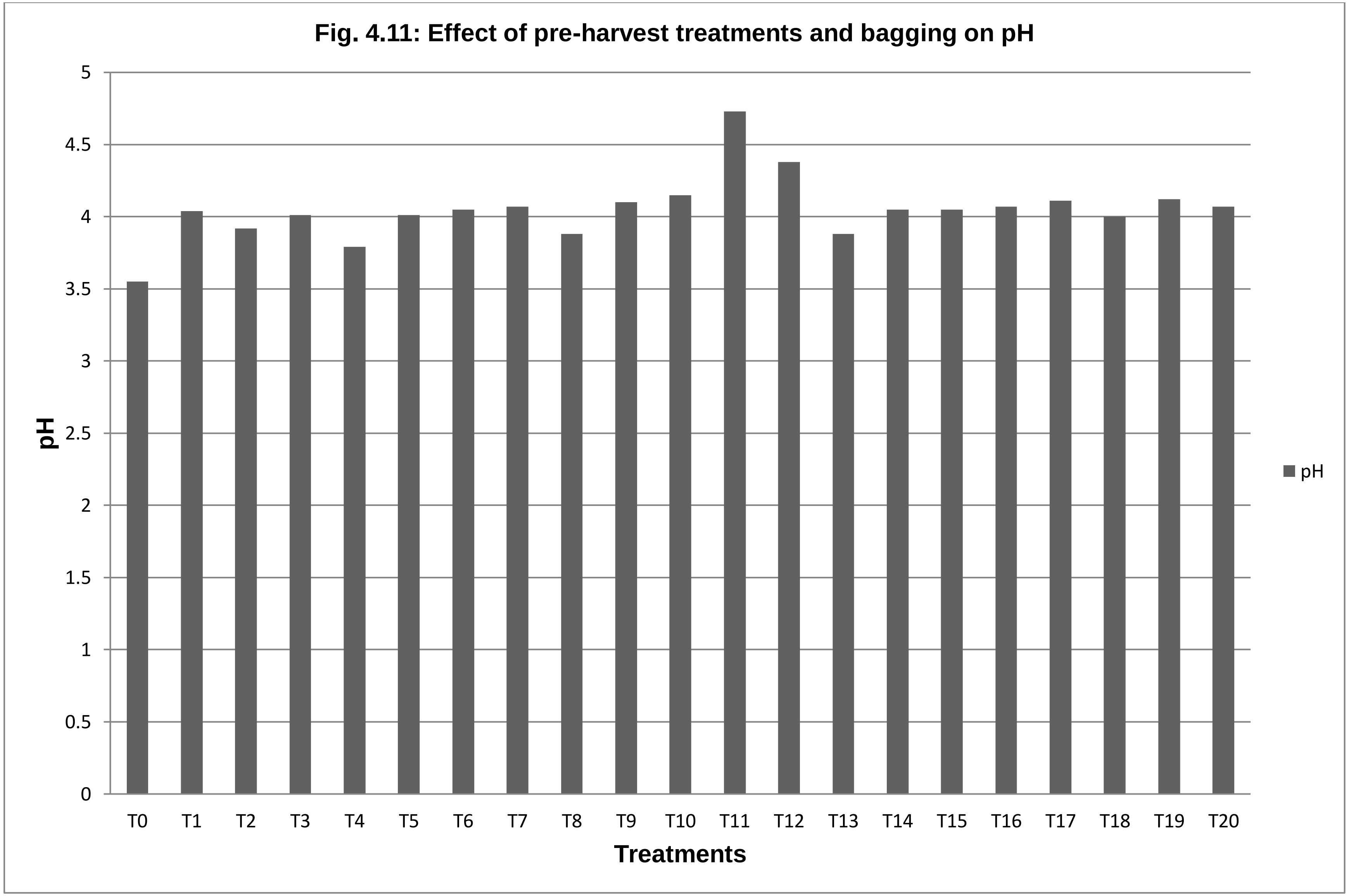


Fig. 4.11: Effect of pre-harvest treatments and bagging on pH
pH
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
T0
T1
T2
T3
T4
T5
T6
T7
T8
T9
T10
T11
T12
T13
T14
T15
T16
T17
T18
T19
T20
Treatments
pH

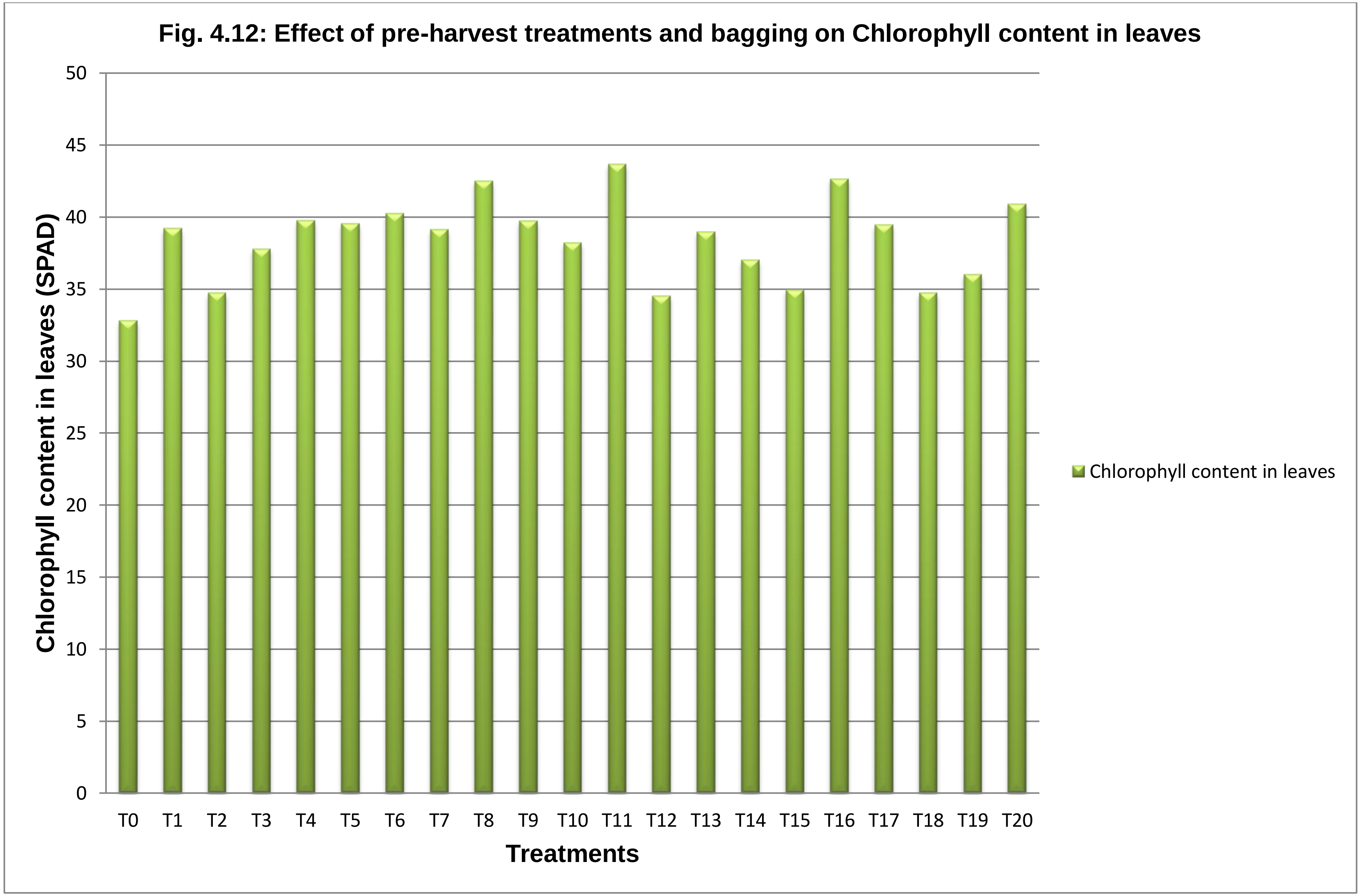


Fig. 4.12: Effect of pre-harvest treatments and bagging on Chlorophyll content in leaves
Chlorophyll content in leaves (SPAD)
50
45
40
35
30
25
20
15
10
5
0
T0 T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 T13 T14 T15 T16 T17 T18 T19 T20
Treatments
Chlorophyll content in leaves

4.3 Organoleptic test:

Data collected on fruit taste, colour, texture and aroma are presented in Table 4.9. Fruit taste, colour, texture and aroma are important characteristics of guava and play an important role in marketing. Yellow ripe stage had significantly higher organoleptic values followed by green yellow and mature green stage. The Analysis of Variance for the same is given in the appendices IV.

4.3.1 Fruit taste:

Data presented in Table 4.9 was due to effect of pre-harvest treatments and bagging.

Data in Table 4.9 revealed that fruit taste was significantly influenced by the treatments applied. Treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) had significant higher values in terms of fruit taste 7.33. Treatment T_{19} (Ascorbic acid @ 300 ppm with Yellow polyethylene) 7.00 was *at par with* treatment T_{11}. Treatments T_6 (Ascorbic acid @ 400 ppm) 6.67 and T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 6.67 followed the treatment T_{11}. Among single doses of spraying, treatment T_3 ($CaCl_2$ @ 2%) had better fruit taste (6.33) and bagging with brown paper the fruits with treatment T_7 (Bagging with brown paper) had very good value in terms of fruit taste (5.67). However, control fruits had the lowest fruit taste under treatment T_0 (Control) 4.33.

4.3.2 Fruit colour:

Data presented in Table 4.9 was due to effect of pre-harvest treatments and bagging.

Data in Table 4.9 revealed that fruit colour was significantly influenced. Treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) had significant higher values in terms of fruit colour (8.00). Treatment T_{11} is followed by treatment T_{12} (Ascorbic acid @ 200 ppm with Brown paper) 7.33 and treatment T_{17} ($CaCl_2$ @ 2% with Yellow polyethylene) 7.33. Whereas, within single doses of pre-harvest spraying, treatment T_3 ($CaCl_2$ @ 2%) had more value of fruit colour (7.33). Bagging wise the fruits with treatment T_7 (Bagging with brown paper) had attained good value in terms of fruit colour (7.33). While, control fruits (T_0) had lowest value for fruit colour (5.33).

4.3.3 Fruit texture:

Data presented in Table 4.9 was due to effect of pre-harvest treatments and bagging.

Data in Table 4.9 shows that texture of fruit was significantly influenced by the pre-harvest treatments and bagging. Treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) had significant higher values in terms of texture of fruit (7.67). Treatment T_{19} (Ascorbic acid @ 300 ppm with Yellow polyethylene) 7.33 was *at par with* treatment T_{11} and followed by treatment T_{12} (Ascorbic acid@ 200 ppm with Brown paper) 6.67 and treatment T_{15} ($CaCl_2$ @ 1% with Yellow polyethylene). Other than treatment combinations of pre-harvest spraying, treatment T_3 ($CaCl_2$ @ 2%) had highest score regarding fruit texture (6.67) and in comparison treatments of bagging treatment T_7 (Bagging with brown paper) had much better in terms of fruit texture (5.00) then yellow polyethylene i.e. treatment T_8. However, treatment T_0 (Control) fruits had the lowest score for fruit texture (4.67).

4.3.4 Fruit aroma:

Data regarding fruit aroma depicted in Table 4.9 due to the effect of pre-harvest treatments and bagging.

Pre-harvest treatments and bagging significantly influenced the fruit aroma (Table 4.9). Treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) scored highest values in terms of fruit aroma (7.33) over than rest of the treatments. Treatment T_{20} (Ascorbic acid @ 400 ppm with Yellow polyethylene) 7.00 was *at par with* treatment T_{11}. Treatments T_2 ($CaCl_2$ @ 1.5%) and T_{10} ($CaCl_2$ @ 1.5% with Brown paper) 6.67 followed the treatment T_{11}. Within single doses of pre-harvest spraying, treatment T_3 ($CaCl_2$ @ 2%) performed more fruit aroma (6.00) and bagging wise the fruits with treatment T_7 (Bagging with brown paper) had much better value in terms of fruit aroma (6.00). Whereas, control fruits (T_0) had lowest value for fruit aroma (4.00).

Table- 4.9: Effect of pre-harvest treatments and bagging on organoleptic test

Treatments		Fruit taste	Fruit colour	Fruit texture	Fruit aroma
T_0	Control	4.33	5.33	4.67	4.00
T_1	$CaCl_2$ @ 1%	5.67	6.33	6.00	6.00
T_2	$CaCl_2$ @ 1.5%	6.00	7.00	6.33	6.67
T_3	$CaCl_2$ @ 2%	6.33	7.33	6.67	6.00
T_4	Ascorbic acid @ 200ppm	5.67	5.67	6.00	5.00
T_5	Ascorbic acid @ 300 ppm	6.33	6.33	6.33	5.67
T_6	Ascorbic acid @ 400 ppm	6.67	6.33	5.67	6.33
T_7	Bagging with Brown paper	5.67	7.33	5.00	6.00
T_8	Bagging with Yellow polyethylene	5.33	7.33	6.00	4.67
T_9	$CaCl_2$ @ 1% with Brown paper	4.67	6.00	5.67	6.33
T_{10}	$CaCl_2$ @ 1.5% with Brown paper	6.67	6.00	6.67	6.67
T_{11}	$CaCl_2$ @ 2% with Brown paper	7.33	8.00	7.67	7.33
T_{12}	Ascorbic acid @ 200 ppm with Brown paper	6.00	7.33	6.67	6.33
T_{13}	Ascorbic acid @ 300 ppm with Brown paper	5.33	7.00	6.00	5.67
T_{14}	Ascorbic acid @ 400 ppm with Brown paper	5.67	6.67	5.67	6.33
T_{15}	$CaCl_2$ @ 1% with Yellow polyethylene	6.67	6.33	6.67	6.33
T_{16}	$CaCl_2$ @ 1.5% with Yellow polyethylene	5.00	6.33	5.00	4.33
T_{17}	$CaCl_2$ @ 2% with Yellow polyethylene	5.67	7.33	6.33	6.67
T_{18}	Ascorbic acid @200 ppm with Yellow polyethylene	5.33	5.67	6.00	6.67
T_{19}	Ascorbic acid @300 ppm with Yellow polyethylene	7.00	6.33	7.33	6.33
T_{20}	Ascorbic acid @400 ppm with Yellow polyethylene	6.33	7.00	6.33	7.00
	S.Em. ±	**0.29**	**0.29**	**0.28**	**0.31**
	C.D. at 5%	**0.84**	**0.82**	**0.81**	**0.89**

Plate No. 4.1- Evaluation of fruits for organoleptic test by panel members

Plate No. 4.2- Evaluation of fruits before analysis by committee members

CHAPTER - V

DISCUSSION

The experiment entitled **"Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L-49 Fruits"** was undertaken in the Department of Fruit Science, College of Horticulture, Mandsaur, during 2019-20. The effect of pre-harvest treatments and bagging on different physical parameters of fruit (length, width, weight, volume, specific gravity and pulp weight) and bio-chemical parameters (Total Soluble Solids, acidity, TSS: acidity ratio, ascorbic acid, pectin, pH and chlorophyll) were studied. Organoleptic tests (fruit taste, fruit colour, fruit texture and fruit aroma) were also studied and observed by the panel members. The results obtained are discussed below:

Physical parameters:

The physical parameters of fruit are an expression of a plant's vegetative activity which was also significantly influenced by various pre-harvest treatments and bagging. Results showed that maximum fruit length (8.25 cm), width (8.72 cm), fruit weight (199.67 g), volume of fruit (197.67 ml) and pulp weight (173.40 g) with the application of T_{11} ($CaCl_2$ @ 2% with Brown paper) at harvest were significantly superior to (control) T_0. The increase in fruit length and width by the application of pre-harvest treatments and bagging might be due to optimum supply of proper plant nutrients in right amount during the entire crop growth period causing vigorous vegetative development of the plants and ultimately production of more food material in fruits.

The combinations $CaCl_2$, Ascorbic acid and bagging accelerate metabolic activities and maintain higher temperature and provide more availability of nutrient to the fruit. Pre-harvest calcium spray is one of the most important practices of new strategies applied in the integrated fruit production systems, improving fruit characteristics and minimizing fungicides sprays towards the end of the harvest period, since they improve fruit resistance to brown rot (Conway et al. 1994). Calcium spray during fruit development provides a safe mode of supplementing endogenous calcium to fresh fruits. Fruit weight, fruit length, fruit width and fruit volume of berries increased with the increase in concentration of calcium. It ultimately leads to improvement in physical characters of the fruit. Similar results have also been reported by Bakshi *et al*. (2013), Behera and Pathak (2015), Chéour *et al*. (1990) in strawberry and Jakhar and Pathak (2016) in mango, Goutam *et al.* (2010), Karemera and Habimana (2014) in mango, Kumar *et al.* (2017) in grapes, Taduri *et al.* (2017) in mango and Mishra *et al.* (2017).

Bagging of fruits is one of the necessary techniques for producing quality fruits and had been universally adopted in the fruit production. Same time in the bagging (Brown paper and Yellow polyethylene) encouraged better chemical composition as quality, which stimulated process of translocation of water and nutrients, growth and development which in turn causes increase in size and weight of the fruits and other physical characters. The present findings are in accordance with the results reported by Sarker *et al*. (2009), Abbasi *et al.* (2014), Islam *et al* (2019), Jakhar and Pathak (2016), Kassem *et al.* (2011) Kireeti *et al.* (2018) in mango and Zhai *et al.* (2006).

Bio-chemical parameters:

Application of $CaCl_2$ and Ascorbic acid along with bagging not only increases the physical characteristics of fruits but also improves the fruit quality. Their application alone or in combination influenced significantly the chemical constituents of the fruit *viz*. TSS, ascorbic acid, TSS: acidity ratio, pectin content, pH and chlorophyll content in leaves over the control. The maxium acidity (0.57%) was in treatment T_0 (control), while maxium Total Soluble Solids (11.50 ^{0}B), maxium ascorbic acid content (192.39 mg), maxium TSS: acidity ratio (26.63), maximum pectin content (1.05%), maximum pH (4.73) and maximum chlorophyll content in leaves (46.10) with the application of T_{11} ($CaCl_2$ @ 2% with Brown paper) at harvest were significantly superior to (control) T_0.

The improvement in various chemical characteristics is due to application of chemical combination treatment beneficially affected in increasing the various contains of fruits hence quality improvement reflected in chemical characters of fruit. Guava responds well to the application of calcium, hence $CaCl_2$ application improves, fruit character and chemical composition through rapid transformation of plant nutrients along with Ascorbic acid application of different concentrations which has stimulating effects over quality parameters of the fruit. Similar findings were also reported by Abbasi *et al.* (2014), Behera and Pathak (2015), Sahar (2014), Goutam *et al*. (2010).

Same time in bagging (Brown paper and Yellow polyethylene) enhanced much better chemical composition with the induction of growth hormones, due to which sufficient movement of water and nutrients which finally responsible for growth and development in qualitative way of fruits and other bio-chemical characters. The present findings are in accordance with the results reported by Abbasi *et al.* (2014), Islam *et al* (2019), Jakhar and Pathak (2016), Kassem *et al.* (2011) and Kireeti *et al.* (2018) in mango, Rahman *et al*. (2018).

Organoleptic test:

Organoleptic test was also improved with the application of pre-harvest treatments of $CaCl_2$ and Ascorbic acid along with bagging of Brown paper and Yellow polyethylene.

Fruits treated with $CaCl_2$ @ 2% and bagging with Brown paper were found significantly superior in organoleptic test with highest scores in terms of taste, colour, texture and aroma (7.33, 8.00, 7.67 and 7.33), respectively and rated as very good, while the control obtained the lowest scores (4.33, 5.33, 4.67 and 4.00), respectively. Similarly, earlier workers have also reported that the fruit bagging can improve fruit quality mainly by keeping fruit appearance and preferable uniform coloration of the fruit as reported in Sarker *et al*. (2009) and Singh *et al*. (2017).

CHAPTER - VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

6.1 Summary:

The investigation entitled **"Effect of Pre-harvest Treatments and Bagging for Quality Improvement of Guava (*Psidium guajava* L.) cv. L-49 Fruits**" was undertaken in the Department of Fruit Science, KNK College of Horticulture, Mandsaur, RVSKVV, Gwalior (M.P.) during the period 2019-20. The observations on different Physical, bio-chemical characteristics as well as organoleptic parameters were recorded and the results obtained and discussed in preceding chapters are summarized below.

Physical parameters:

The physical characteristics of fruits were significantly affected by the spraying of $CaCl_2$, Ascorbic acid, Brown paper bagging and Yellow polyethylene bagging alone or in combination. Result showed that maximum fruit length (8.25 cm), width (8.72 cm), fruit weight (199.67 g), volume of fruit (197.67 ml) and pulp weight (173.40 g) recorded with the application of T_{11} ($CaCl_2$ @ 2% with Brown paper) were significantly greater than control T_0 and over the rest of the treatments.

Bio-Chemical parameters:

The bio-chemical characteristics of the fruits were affected significantly by pre-harvest spraying ($CaCl_2$ and Ascorbic acid) and bagging (Brown paper bagging and Yellow polyethylene bagging). Their spraying alone or in combination significantly influenced the chemical constituents of the fruit *viz*. TSS, ascorbic acid, TSS: acidity ratio, pectin content, pH of the fruit and chlorophyll content in leaves over the control. The maximum ascorbic acid (192.39 mg/ 100g pulp), Total Soluble Solids (11.50 ^{0}Brix), TSS: acidity ratio (26.63), pectin content (1.05%), pH (4.73) and chlorophyll content (46.10) were recorded in application of treatment T_{11} ($CaCl_2$ @ 2% with Brown paper) which were significantly higher over control T_0.

Organoleptic test:

The organoleptic characters of fruits are an expression of a fruit's sensory activity which was also significantly influenced by various pre-harvest treatments along with bagging. Results showed that maximum value of fruit taste (7.33) and colour (8.00) at harvest, fruit texture (7.67) and fruit aroma (7.33) with the spraying of T_{11} ($CaCl_2$ @ 2% with Brown paper) were significantly superior to control T_0.

6.2. Conclusion:

It can be concluded from the results obtained on the basis of present investigation for 10 years old guava cv. L- 49 that the maximum values regarding to physical, bio-chemical and organoleptic parameters are obtained under the treatment T_{11} ($CaCl_2$ @ 2% with Brown paper). It has been found the most appropriate pre-harvest treatment dose along with bagging under agro-climatic conditions of Malwa Plateau region for improving the physical characteristics along with bio-chemical quality of the fruits and it also gives better organoleptic test.

6.3. Suggestions for further work:

On the basis of the results obtained, the following suggestions are made for future research work.

1. The present experiment was conducted for the first time and hence, may be repeated for confirmation of the findings.
2. Findings of present investigation need to be popularized among fruit farmers and growers.
3. Experiment should be done with more different varieties of guava under Malwa Plateau agro-climatic conditions.
4. The investigation should also be tested under different agro-climatic conditions.

REFERENCES

A.O.A.C. (2000). Official Methods of Analysis. Association of the Official Analytical Chemists, Washington, D.C.13th Edn.

Abbasi, N.A.; Chaudhary, M.A.; Ali, M.I.; Hussain, A. and Ali, I. (2018). On tree fruit bagging influences quality of guava harvested at different maturity stages during summer. *Int. J. Agric. Biol.* **16**(3): 543–549.

Abdel Gawad-Nehad, M.A.; EL-Gioushy, S.F. and Baiea, M.H.M. (2017). Impact of different bagging types on preventing sunburn injury and quality improvement of keitt mango fruits. *Middle East J. Agric. Res*. **6**(2): 484-494.

Abdou, M.A.H.; Ahmed, E.E.T. and Ibrahim, T.I.E. (2015). Effect of nitrogen sources and ascorbic acid on growth and essential oil production of geranium (*Pelargonium graveolens*, L.) plants. *Sci. J. Flowers and Ornamental Plants*. **2**(2): 157-165.

Aly M.A.; Ezz; Thanaa, M.; Abd El-Gawad, M.G. and Buazizah, M.H.S. (2019). Enhancement quality and storability of "anna" apple fruits by some pre-harvest foliar applications. *Middle East Journal Of Agric. Res.* **8**(1): 66-81.

Amarante, C.; Banks, N.H. and Max, S. (2002). Effect of preharvest bagging on fruit quality and postharvest physiology of pears (*Pyrus communis*). *New Zealand J. Crop Hort. Sci*. **30**: 99–107.

Anonymous (2018). Horticultural Statistics at a Glance 2018, *Horticulture Statistics Division Department of Agriculture, Cooperation & Farmers Welfare Ministry of Agriculture & Farmers Welfare Government of India*.

Bakshi, P.; Jasrotia, A.; Wali, V.K.; Sharma, A. and Bakshi, M. (2013). Influence of pre-harvest application of calcium and micro-nutrients on growth, yield, quality and shelf-life of Strawberry cv Chandler. *Indian J. Agric. Sci.* **83**(8): 831–5.

Bal, L.M.; Ahmad, T.; Senapati, A.K. and Pandit, P.S. (2014). Evaluation of quality attributes during storage of guava nectar cv. Lalit from different pulp and TSS ratio. *J. Food Process Technol.* **5**: 329.

Behera, S.D. and Pathak, S. (2015). Pre-harvest treatments for fruit quality improvement in rainy season guava (*Psidium guajava*). *Internat. J. Sci. Res*. **6**(10): 1358-1361.

Bentley, W.J. and Viveros, M. (1992). Brown-bagging 'granny smith' apples on trees stops codling moth damage. *California Agric*. **46**: 30–32.

Chéour, F.; Willemot, C.; Arul, J.; Desjardins, Y.; Makhlouf, J.; Charest, P.M. and Gosselin, A. (1990). Foliar application of calcium chloride delays postharvest ripening of strawberry. *J. American Soc.. Hort. Sci.* **115**(5): 789-792.

Conway, W.S.; Sams, C.E. and Kelman, A. (1994). Enhancing the natural resistance of plant tissue to post-harvest diseases through calcium applications. *Hort. Sci*. **29**: 751-161.

Dewick, P.M. (2000). Medicinal Natural Products: A Biosynthetic Approach, 2nd Ed., John Wiley and Sons, N.Y. pp: 306–356.

Dhaliwal, G.S. and Singla, R. (2002). Studies on the time of anthesis and dehiscence in different genotypes of guava in winter and rainy season crops. *Indian J. Hort*. **59**: 157-161.

El Sayed, M.A.; Mervat, A.A. and Ali, A.H. (2000). Response of flame seed less grapevine to application of ascorbic acid. The 2nd *Conf. Agric. Sci.* Assiut, Egypt, pp: 317-340.

El-Badawy, H.E.M. (2013). Effect of some antioxidants and micronutrients on growth, leaf mineral content, yield and fruit quality of canino apricot trees. *J. of Appl. Sci. Res*. **9**(2): 1228-1237.

El-Badawy, H.E.M.; El-Gioushy, S.F.; Baiea, M.H.M. and EL-Khwaga, A.A. (2017). Effect of some antioxidants and nutrients treatments on vegetative growth and nutritional status of washington navel orange trees. *Middle East J. of Agric.* **6**(1): 87-98.

Gerasopoulos,D.; Chouliaras, V. and Lionakis, S. (1996). Effect of preharvest calcium chloride spray on maturity and storability of Hayward kiwifruit. *Postharvest Biol. Technol.* **7**: 65–72.

Hofman, P.J.; Smith, L.G.; Joyce, D.C.; Johnson, G.L. and Meiburg, G.F. (1997). Bagging of Mango (*Mangifera indica* cv. 'Keitt') fruit influences fruit quality and mineral composition. *Postharvest Biol. Technol.* **12:** 83–91.

Islam, M.T.; Shamsuzzoha, M.; Rahman, M.S.; Bari, M.A.; Akter, M.M.; Khatun, A.; Huque, R. and Uddin, M.S. (2019). Effect of bagging time on fruit quality and shelf life of Mango (*Mangifera indica* L.) cv. Langra in Bangladesh. *Int. J. of Agric. Environ. Biores.* **4**: 279-289.

Ismail, S.I.I. (2008). Anatomical and physiological studies on *Nigella sativa*, L. plant. Ph.D. thesis. Fac. Agric., Mansoura Univ., Egypt, Pp: 205-211

Jagtiani, J.; Chan, H.T. and Sakai, W.S. (1988). Tropical Fruit Processing. *New York Academic Press* Inc. Pp. 9-43.

Jakhar, M.S. and Pathak, S. (2016). Effect of pre-harvest nutrients application and bagging on quality and shelf life of Mango (*Mangifera indica* L.) fruits cv. Amrapali. *J. Agr. Sci. Technol.* **18**: 717-729.

Jakhar, M.S. and Pathak, S. (2014). Enhancing quality of Mango (*Mangifera indica* L.) fruits cv. Amrapali with pre-harvest foliar spray and fruit bagging, *Ann. Agric. Biores*. **19**(3): 488-491.

Jayachandran, K.S.; Srihari, D. and Reddy, Y.N. (2005). Changes in post-harvest quality of guava fruits affected by pre-harvest application of growth regulators. *Agric. Sci. Digest*. **25**(3): 210–212.

Joshi, K.K.; Singh, V.P.; Saxena, D. and Mishra, D.S. (2016). Effect of pre harvest bagging on fruit quality of litchi (*Litchi chinensis* Sonn) cv. Rose Scented. *Annals of Horticulture*. **9**(1): 41.

Joyce, D.C.; Beasley, D.R. and Shorter, A.J. (1997). Effect of pre-harvest bagging on fruit calcium levels, and storage and ripening characteristics of 'sensation' mangoes. *Australian J. of Exp. Agric.* **37**: 383–389.

Karemera, N.J.U. and Habimana, S. (2014). Effect of pre-harvest calcium chloride on post harvest behavior of Mango fruits (*Mangifera indica* L.) cv. Alphonso. *Universal J. of Agric. Res.* **2**(3): 119-125.

Karemera, N.J. U. and Habimana, S. (2014). Performance of calcium chloride sprays on ripening, shelf-life and physical chemical proprieties of Mango Fruits (*Mangifera indica* L.) cv.Totapuri. *Int. Invention J. of Agric. Soil Sci.* **2**(3): 33-38.

Kassem, H.A.; Omar, A.K.H. and Ahmed, M.A. (2011). Response of zaghloul date palm productivity, ripening and quality to different polyethylene bagging treatments. *American-Eurasian J. Agric. Environ. Sci.* **11**(5): 616-621.

Kireeti, A.; Haldankar, P.M. and Parulekar, Y.R. (2018). Studies on effect of types of bag on Mango fruit (cv. Kesar) at egg stage. *Int. J. of Chemical Studies*. **6**(6): 01-04.

Kitagawa, H.; Manabe, K. and Esguerra, E.B. (1992). Bagging of fruit on the tree to control disease. *Acta Hort.* **321**: 871–875.

Kitagawa,H.; Manabe, K. and Esguerra, E. (1991). Bagging of fruit on the tree to control disease. Front Trop Fruit Res, **321**: 871–875.

Madani, B.; Mohameda, M.T.M.; Watkins, C.B.; Kadir, J.; Awanga, Y. and Shojaei, T.R. (2014). Preharvest calcium chloride sprays affect ripening of eksotika ii'papaya fruits during cold storage. *Scientia Horticulturae.* **171**: 6–13.

Maji, S. (2010). Studies on organic nutrition, intercropping and crop regulation in Guava (*Psidium guajava* L.) cv. L-49. Ph.D Thesis 3.

Maksoud, M.A.; Salah, M.S.; El-Shamma and Faud, A.A. (2009). The effect of biofertilizers and antioxidants on olive trees under calcareous soil conditions. *World J. Agric. Sci*. **5**: 350-352.

Meena, K.R.; Maji,S.; Kumar, S.; Parihar, D. and Meena, D.C. (2016). Effect of bagging on fruit quality of Guava. *Int. J. of Bio-Resource and Stress Management* **7**(2): 330-333.

Mishra, K.K.; Pathak, S.; Sharma, N. and Nehal, N. (2017). Effect of pre-harvest nutrients spraying on physicochemical quality and storage behavior of rainy season Guava (*Psidium guajava* L.) fruits cv. L-49. *Plant Archives.* **17**(1): 597-600.

Nagaharshitha, D.; Khopkar, R.R.; Haldankar, P.M.; Haldavanekar, P.C. and Parulekar, Y.R. (2014). Effect of bagging on chemical properties of Mango (*Mangifera indica* L.) cv. Alphonso. *Agrotechnol*. **3**(1): 1-4.

NHB (2018). National Horticulture Database. National Horticulture Board. Govt. India, Gurgaon, India. www.nhb.gov.in.

Omar, A.E.D.K. and El Shemy, M.A. (2014). Enhancing development, rate of ripening and quality of date palm fruit (*Phoenix dactylifera* l.) cv. Zaghloul by bagging pre-harvest treatment. *Int. J. of Modern Agric.* **3**(2): 39-45.

Patel, H.A.; Patel, M.J.; Vasara, R.; Patel, N.G. and Sutariya, N.K. (2017). Effect of pre-harvest spray of calcium on bio-chemical parameters of Sapota (*Manilkara achras* Mill.) fruits cv. Kalipatti. *J. of Pharmacognosy And Phytochemistry.* **6**(5): 712-715.

Pathak, R.K.; Singh, G.; Kishun, R. and Chandra, R. (2007). Improvement of Guava (*Psidium guajava* L.) Through Breeding. **85**(1): 0567-7572 .

Penter, M.G. and Stassen, P.J.C. (2000). The effect of pre- and postharvest calcium applications on the postharvest quality of Pinkerton Avocados. *South African Avocado Growers' Association Yearbook*. **23**: 1-7.

Peryam, D.R. and Pilgrim, F.J. (1957). Hedonic scale method of measuring food preferences. *Food Technol. Suppl.* 9–14.

Piper, C.S. (1966). Soil and Plant analysis. Hans Publisher, Bombay.

Prabha, S.; Kumari, K. and Deb, P. (2018). Effect of fruit bagging on physico–chemical properties of Pineapple cv. Mauritius. *Int. J. Curr. Microbiol. App. Sci*. **7**: 4876-4885.

Raese, J.T. and Drake, S.R. (2000). Effect of calcium sprays, time of harvest, cold storage, and ripeness on fruit quality of 'Anjou' Pears. *J. Plant Nutr.* **23**: 843–853.

Rahman, M.M.; Hossain, M.M. Rahim, M.A.; Rubelmd, H.K. and Islam M.Z. (2018). Effect of pre-harvest fruit bagging on post-harvest quality of Guava cv. Swarupkathi. *Fundam. Appl. Agric*. **3**(1): 363–371.

Rajput, B.S.; Sharma, G.K. and Singh, I. (2008). Effect of pre and post harvest treatments on shelf life and quality of Guava fruits (*Psidium guajava* L.) cv. Gwalior- 27. *The Asian.J. Hort.* **3**(2): 368-371.

Rangana, S. (2013). Manual for analysis of fruit and vegetable products. Tata Mcgraw Co. Pvt. Ltd. New Delhi.

Salunkhe, D.K. and Kadam, S.S. (1995). Handbook of fruit science and technology production, composition, storage and processing. Marcel Dekker, Inc. pp: 419-433.

Santarre, C.R.; Cash, J.N. and Vannorman, D.J. (1988). Ascorbic acid/ citric acid combinations in the processing of frozen apple slices. *J. of Food Sci.* **53**: 1713-1716.

Sapers, G.M.; Hicks, K.B.J.G.; Philipps, L.; Garzarella, D.L.; Pondish, T.J.; Mccormick, S.M.; Sondey, P.A. Scib and El-Ataway, Y.S. (1989). Control of enzymatic browning in apple with ascorbic acid derivatives, polyphenoloxidase inhibitors and complexing agents. *J. of Food Sci.* **54**: 997-1002.

Sarker, D.; Rahman, M.M. and Barman, J.C. (2009). Efficacy of different bagging materials for the control of mango fruit fly. *Bangladesh J. Agril. Res.* **34**(1): 165-168.

Sharma , R.R.; Reddy, S.V.R. and Jhalegar, M.J. (2014). Pre-harvest fruit bagging: a useful approach for plant protection and improved post-harvest fruit quality. *J. of Hort. Sci. Biotechnol.* **89** (2): 101–113.

Sharma, N.K.; Pathak, S.; Singh, R.P.; Singh, A.; Rai, M.; Singh, A.P. and Singh, A. (2018). Effect of chemicals & bagging along with chemical attributes of rainy season Guava (*Psidium guajava* Linn.) cv. Lucknow-49. *Int. J. of Chem. Stud.* **6**(6): 2687-2690.

Singh, R.K.; Shah, N.I. and Solanki, P.D. (2017). Influence of fruit bagging on chemical quality of Mango (*Mangifera indica* L.) varieties. *Int. J. Plant Soil Sci.* **18**(3): 1-7.

Singh, R.P.; Tandon, D.K. and Kalra, S.K. (1993). Change in post-harvest quality of mangoes affected by pre-harvest application of calcium salts. *Sci. Hort*. **54**: 211–219.

Singh, J. and Mirza, A. (2018). Influence of ascorbic acid application on quality and storage life of fruits. *Int. J. Curr. Microbiol. App. Sci.* **7**(7): 4319-4328.

Son, I.C. and Lee, C.H. (2008). The effects of bags with different light transmittance on the berry cracking of Grape 'Kyoho'. *Hortic. Environ. Biotechnol*. **49**: 98–103.

Taduri, M.; Reddy, N.N.; N, J.L. and Joshi, V. (2017). Effect of pre harvest treatments on shelf life and quality of Mango cv. Amrapali. *The Pharma Innovation J.* **6**(7): 54-59.

Tyas, J.A.; Hofman, P.J.; Underhill, S.J.R. and Bell, K.L. (1998). Fruit canopy position and panicle bagging affects yield and quality of `Tai So' Lychee. *Scientia Horticulturae.* **72**: 203–213.

Tzoutzoukou, C.G. and Bouranis, D.I. (1997). Effect of pre-harvest application of calcium on Apricot fruit. *J. Plant Nutr*. **20**: 295–309.

Xu, H.X.; Chen, J.W. and Xie, M. (2010). Effect of different light transmittance paper bags on fruit quality and anti-oxidant capacity in Loquat. *J. of Sci. Food Agric.* **90**: 1783–1788.

Zhai, H.C.; Ren, E.M.; Li, D.C.; Shi, G.Y.; Lin and Liu, X.Y. (2006). The effect of different bagging periods on the quality of red Fuji apple in Weibei dry land. *J. Northwest For. Univ.,* **20**: 188–120.

Zhou, J.; Zhong, G.; Lin, Z. and Xu, Hui-Lian. (2012). The effects of bagging on fresh fruit quality of Canarium Album. *J. Food Agric. Environ.* **10**(1): 505-508.

Appendices

Appendix- I

Analysis of variance for physical characteristics of fruit

S.V.	D.F.	M.S.S.					
		Fruit length	**Fruit width**	**Fruit weight**	**Fruit volume**	**Specific gravity**	**Pulp weight**
Replication	2	0.21	0.10	70.58	14.32	0.01	102.38
Treatment	20	1.00*	0.93*	1397.42*	1073.43*	0.01	1258.46*
Error	40	0.12	0.39	331.70	5.68	0.01	437.19
Total	62						

*Significant at 5 percent level

Appendix- II

Analysis of variance for bio-chemical characteristics of fruit

S.V.	D.F.	M.S.S.			
		TSS	**Acidity**	**TSS: acidity ratio**	**Ascorbic acid content**
Replication	2	0.12	0.00	0.30	35.57
Treatment	20	1.31*	0.01*	29.27*	712.63*
Error	40	0.51	0.00	7.09	98.89
Total	62				

*Significant at 5 percent level

Appendix- III

Analysis of variance for bio-chemical characteristics of fruit

S.V.	D.F.	M.S.S.		
		Pectin content	pH	Chlorophyll content in leaves
Replication	2	0.00	0.59	4.91
Treatment	20	0.02*	0.15*	433.35*
Error	40	0.01	0.06	4.02
Total	62			

*Significant at 5 percent level

Appendix- IV

Analysis of variance for organoleptic tests of fruit

S.V.	D.F.	M.S.S.			
		Fruit taste	Fruit colour	Fruit texture	Fruit aroma
Replication	2	6.87	0.02	12.44	6.33
Treatment	20	6.45*	23.08*	11.65*	15.62*
Error	40	0.77	0.75	0.73	0.87
Total	62				

*Significant at 5 percent level

VITA

The author of this thesis **SARANSH SAXENA** was born on 27th June 1996 at village- Hansrod, Tehsil- Biaora, District- Rajgarh (M.P.). He passed Secondary Examination in the year 2011 and Senior Secondary Examination in the year 2013 from MPBSE Bhopal with 94.16 % and 90.40 % marks respectively.

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