Effect of Foliar Application of Borax and Zinc sulphateon Growth, Yield and Quality of Guava*(Psidiumguajava*L.)cv. Gwalior 27

THESIS

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(FRUIT SCIENCE)

by

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2017

CERTIFICATE – I

This is to certify that the thesis entitled **Effect of foliar application of Borax and Zinc sulphate on growth, yield and quality of Guava (*Psidiumguajava*L.)Cv. Gwalior 27***submitted in partial fulfillment of the requirements for the degree of* **MASTEROFSCIENCEINHORTICULTURE(FRUIT SCIENCE)** in the **Department of Horticulture***of* RajmataVijyarajeScindiaKrishiVishwaVidyalaya, Gwalior (M.P.) *is a record of the bona-fide research work carried out by* **KOMAL YADAV***under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of 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 the investigation has been acknowledged by the scholar.

Signature

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Chairman of the advisory committee

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Chairman (Dr.A.K.Barholia) :…………………………………

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Member (Mrs.Rajni Singh Sasode) :…………………………………

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CERTIFICATE – II

This is to certify that the thesis entitled **Effect of foliar application of Borax and Zinc sulphate on growth, yield and quality of Guava (*Psidiumguajava*L.)cv. Gwalior 27***submitted by* **KOMAL YADAV***to the* RajmataVijyarajeScindiaKrishiVishwaVidyalaya, Gwalior *in partial fulfillment of the requirements for the degree of Master of Science in* **HORTICULTURE(FRUITSCIENCE)** *in the Department of* **Horticulture** *has been accepted after evaluation, by the External Examiner and approved by the Student's Advisory Committee after an oral examination of the same.*

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Place – GWALIOR ***(KOMAL YADAV)***

Date – / / 2017

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LIST OF ABBRIVIATIONS

Abbreviations/ Acronyms	Meaning
Ag.	Agriculture
ANOVA	Analysis of variance
B	Borax
Cm	Centimetre
^{o}C	Degree celcius
cv.	Cultivar
C.D	Critical difference
Dist.	District
dSm^{-1}	Deci Siemens per meter
et al.	And others
etc.	Etcetera
Fig.	Figure
G	Gram
Ha	Hectare
Hort	Horticulture
i.e.	In reference to; that is
Kg	Kilogram
Max.	Maximum
M	Metre
Ml	Milliliter
Mm	Millimeter
Min	Minimum
M.P.	Madhya Pradesh
M.S.S	Mean Sum of Square
No.	Number
NS	Non significant

Q	Quintal
R.V.S.K.V.V.	RajmataVijayarajeScindiaKrishiVishwaVidhyalaya
S.Em ±	Standard Error of Means
Sy.	Symbol
S	Significant
Temp.	Temperature
TSS	Totle soluble solid
Var.	Varity
Viz	Namely
Wt.	Weight
Z	Zinc sulphate
&	And
@	At the rate of
%	Per cent
/	Per

Chapter-I
INTRODUCTION

Guava (*Psidiumguajava* L.), the Guava (*Psidiumguajava* L.), the apple of the tropics, is one of the most popular fruit plant grown in tropical, sub-tropical and some parts of arid regions of India. The fruit belongs to the family Myrtaceae. It is the fifth most important fruit in area after mango, citrus, banana, and apple and fifth most important fruit in production after banana, mango, citrus and papaya.This fruit originated in tropical America and seems to have been growing from Mexico to Peru.

Guava is an evergreen, shallow-rooted shrubs or small tree 9 m tall with spreading branches. The bark is smooth, mottled green or reddish brown and peels off in thin flakes to reveal the attractive "bony" aspect of its trunk. The plant branches remain close to the ground and often produce suckers from roots near the base of the trunk. Young twigs are quadrangular and downy. Leaves are opposite, simple, short-petioles, entire, oval to oblong-elliptic, somewhat irregular in outline, 5-15 cm long and 2.5-5.0 cm wide. The dull-green, stiff but leathery leaves have pronounced veins, and are slightly downy on the underside. Crushed leaves are aromatic. Flowers white, fragrant, borne singly or in clusters in the leaf axils, are 2.5 cm wide, with 4 or 5 white petals. These petals are quickly shed, leaving a prominent tuft of perhaps many white stamens tipped with pale-yellow anthers. Fruits may be round, ovoid or pear-shaped, 5-10 cm long, and have 4 or 5 protruding floral remnants (sepals) at the apex. Varieties differ widely in flavor and seediness. The better varieties are soft when ripe, creamy in texture with a rind that softens to be fully edible. The flesh may be white, pink, yellow, or red. The seeds are numerous but small and, in good varieties, fully edible.

It's cultivation is done throughout the tropical and sub-tropical regions of the world. In India, it was introduced in early seventeenth century and gradually became a crop of commercial significance all over the country. India is one of the leading producers of guava in the world. In India, guava is cultivated in an area of 268 thousand hectares with production of 3668 thousand MT. The productivity of guava in India is 13.7 MT/ha (Anonymous,2014).The total area and production of Guava in Madhya Pradesh are 21.28 thousand hectares and 801.00 thousand MT, respectively. Madhya Pradesh ranks first in productivity with 37.6 MT/ha.

Guava shares 3.4 percent of area and 3.9 percent of production in India (Anonymous, 2014).

The major guava producing states of India are Uttar Pradesh, Bihar, Maharashtra, Andhra Pradesh, Gujarat, Madhya Pradesh, Karnataka, Punjab, and Odisha. Major guava producing areas in Madhya Pradesh are Jabalpur, Bhopal, Rewa, Neemuch, Ratlam, Gwalior, Khandwa and Mandsaur. Uttar Pradesh produces best quality guava, and Allahabad has the distinct reputation for growing the best guava in the country as well in the world. Chambal is an important region of Madhya Pradesh, where guava is widely grown and several guava orchards are found in and around Gwalior district.

It is also a chief and very rich source of vitamin–C, carbohydrate, iron, fat and contains a fair amount of calcium, phosphorous as well. Guava fruits are also used for preparation of salad, chutney, jam, jelly, nectar etc. These qualities make guava an important and one of the most popular fruits of India.

Guava fruits are rich in nutritional and medicinal properties. The fruit is an excellent source of vitamin–"C" (210-305mg/100g fruit pulp) and pectin (0.51.8%) but has low energy (66cal/100g fruit pulp).The ripe fruits contain 12.3-26.3% dry matter, and 77.9-86.9% moisture. The fruits are also rich in minerals like Phosphorus (22.5-40.0mg/100g fruit pulp), Calcium (10.0-30.0mg/100g pulp) and Iron (0.60-1.39mg/100g fruit pulp) as well as vitamins like Niacin (0.20-2.32mg/100g fruit pulp),Thiamine (0.03-0.07mg/100g fruit pulp), Riboflavin (0.02-0.0mg\100gm fruit pulp) and Vitamin–"A" (Bose and Sanyal, 2001).

Guava fruit is relished when mature or ripe, and freshly plucked from the tree. Excellent salad and pudding are prepared from the shell of the ripe fruit. It can be preserved by canning with or without seeds.

Guava has earned the popularity as "Poor man's apple" available in plenty to every person at very low price during the season. It is no inferior to apple for its nutritive value. It is pleasantly sweet and refreshingly acidic in flavor and emits sweet aroma. It is wholly edible along with the skin. Several delicious preserved products like Jam, Jelly, Cheese, Puree, Ice cream,canned fruit and Sherbat are prepared from ripe fruits of guava. In some countries, the leaves are used for curing and also for dyeing and tanning.

Guava does equally well under tropical and sub tropical climatic conditions. Under tropical climate due to availability of continuous heat and humidity, it produces fruits almost continuously. However in subtropical climate, there are three distinct periods of growth and fruiting. These three distinct periods are, Ambebahar- February to March flowering and fruit ripens in July- August, Mrigbahar- June to July flowering and fruit ripens October to December and Hasta bahar- October to November flowering and fruit ripens in February to April (Shukla *et al*., 2008).

Boron is a multipurpose and crucial element for the plants. Boron is much required for cell division and development in the growth regions of the plant near the tips of shoots and roots. Boron affects pollination and the development of viable seeds which in turn affect the normal development of fruit. A shortage of boron also causes cracking and distorted growth in fruit with appearance of red spots on the newly emerged leaves. Leaves become dry and brittle. The size and quality of guava fruit can be increased greatly by foliar application of borax.

Zinc sulphate increases the growth and development of fruit. Zinc is an essential nutrient for plants, being involved in many enzymatic reactions and is necessary for good growth and development. Zinc is also involved in regulating the protein and carbohydrate metabolism.Similarly zinc also increases the chlorophyll content of leaves and essential for enzyme activities like catalase, peroxidase and cytochrome chlorophyll oxidase.

Gwalior-27 is a popular variety in Northern Madhya Pradesh. Gwalior-27 cultivar is a selection from AllahbadSafeda. Tree is semi-vigorous, medium height and prolific bearer. Fruits are medium , globose , each weighing on an average 225g with few soft seeds, creamy white epicarp with red spots or blush, snow-white pulp, TSS 12.5-14.0^0 Brix, vitamin C 300mg per 100g pulp and good keeping qualities. Fruits are attractive with good nutritive value.

Gwalior is an important region in Madhya Pradesh, where guava is widely grown and several guava orchards are found in and around the Gwalior district. However, these guava orchards are declining in their productivity and one of the reasons for decline could be the lack of application of optimum doses of Boron and Zinc besides some other reasons. Therefore, there is an urgent need to find out appropriate doses of Boron and Zinc for guava fruit crop to improve the productivity.

Keeping the above facts in view, an experiment entitled **"Effect of foliar application of Borax and Zinc sulphate on growth, yield and quality of guava**

(Psidiumguajava L.) cv.Gwalior 27" is being proposed to be conducted in the Agrotechnology Park of Krishi Vigyan Kendra, College of agriculture,Gwalior (M.P.) with following objectives.

1. To assess the influence of Borax and Zinc sulphate on growth, development and yield of guava.
2. To find out the most suitable concentration of Borax and Zinc sulphate for optimizing the fruit yield of guava.
3. To work out the economics of different treatments.

Chapter-II
REVIEW OF LITERATURE

In this chapter, an attempt has been made to review the research work done so far in India and abroad by different workers on the effect of different levels of borax and zinc sulphateon growth, yield and quality parameters of guava cv. Gwalior 27.

2.1 Growth and yield parameters

Sharma *et al.*(1991) advocated that foliar application of 0.6 per cent zinc sulphate resulted in significantly highest fruit set (71.96%), number of fruits (498.6/plant), yield (82.39 kg/plant) in guava.

Bagali*et al.* (1993) reported that two sprays of zinc sulphate, magnesium sulphate and boron increased fruit set per shoot, fruit retention per shoot, number of fruits per tree and fruit yield per tree. Among the different treatments, foliar application of Zn and Mg singly increased the fruit yield significantly as 99.53kg and 87.90kg/ tree, respectively.

Ingle *et al*. (1993) reported that foliar application of borax (0.2%) and zinc sulphate (0.4%) increased fruit yield in guava cv. L-49.

Banik*et al*. (1997) found that foliar application of zinc, iron and boron, each at 0.1, 0.2 and 0.4 per cent significantly influenced flowering and fruiting of 30 year old mango cv. Fazali.

Pradeep and Sharma (1997) stated that the foliar spray of 0.75 per cent zinc sulphate increased fruit yield of citrus cv. Kinnow.

Singh and Vashistha (1997) reported that foliar application of 0.5 per cent ZnSO4 and borax was most effective to minimize drop in ber cv. Seb.

Kaul and Mathew (1999) observed that foliar application of calcium nitrate or zinc sulphate increased the fruit retention percentage in peach cv. Floridasun.

Kundu and Mitra (1999) sprayed guava tree with 0.3 per cent Zn and observed high percentage of fruit set and yield per plant over control.

Stamper *et al*. (1999) reported that foliar application of zinc, borax and phosphorus increased yield up to 30 per cent in apple.

Balakrishnan (2000) reported that foliar spray of 1.0 per cent Zinc sulphate resulted in increase in length of shoot, over control. The micronutrients were applied individually at 1%; or in combination at 0.25 and 0.5% for Zn, Mg and Fe, and 0.1 and 0.2% for Borax. The application of all micronutrients individually or in combination significantly increased the growth of guava as compared to the control.

EI-Sherif*et al.* (2000) observed that the foliar spray of K2S04 (1.0% or 2%) andZincSulphate (0.5% or 1%) on guava at full bloom stage significantly increased the shootlength.

Bhatia *et al.* (2001) reported that guava responded to Zinc up to 0.75 per cent concentration on fruit yield per plant. They also carried out an experiment on guava in which K2SO4 (0.5, 1.0 and 1.5%), ZnSO4 (0.5, 0.75 and 1.0%), H3BO3 (0.3, 0.5 and 1.0) and water (control) were sprayed on the trees and reported that all the nutrients increased yield which was maximum (73.0kg per tree) with H3BO3 1.0%.

Das *et al.* (2001) sprayed the guava trees with 0.5 or 1.0 per cent aqueous solution of zinc sulphate or with water (control) 25-27 days after fruit set and fruits were analyzed after 15, 54 and 93 days of spray. Both concentrations of $ZnSO_4$ had elevated total, reducing and non-reducing sugars content of the fruits over control and at a higher rate with the higher concentration. The treatment also increased the weight of fruits but the specific gravity did not change much.

Prabu and Singaram (2001) reported the effect of Zn and B on the yield of grapes. The treatments were ZnSO4 0.5% (10 and 20 g per vine) and borax 0.2% (4 and 8 g), alone and in combinations. Foliar applications were conducted during the vegetative and full bloom stages. The yield (6.30 kg per vine) was highest with ZnSO4 + borax treatments.

Lal and Sen (2002) reported that foliar application of Zinc (0, 2 and 4 g/plant) significantly influenced flowering, fruiting, yield attributes and yield of guava.

Maksoud*et al*. (2004) reported the effect of boron (B) fertilizer on yield of olive (cv. Chemlali). Treatments comprised: (1) control treatment (without B fertilizer), (2) soil application of B fertilizer as boric acid (500 ppm), (3) foliar B application with boric acid (500 ppm) combined with or without 0.2% urea. Boron sprays were applied before or after bloom. The appreciable increase in yield was obtained from B sprays combined with urea after bloom.

Meena*et al.* (2005) reported the combined effect of urea (2.0, 2.5 and 3.0%) and ZnSO4 (0.5, 1.0 and 1.5%) as foliar sprays on the yield of pruned guava (cv.

Sardar) under high-density planting system. The greatest number of fruits per plant (346.67) and yield of fruit (42.75 kg per plant) were recorded with the foliar application of 3.0% urea + 1.0% ZnSO4.

Prasad *et al.* (2005) found that 0.8% borax significantly increased the number of flowers, fruit set, and fruit retention of guava cv. AllahbadSafeda. All the treatments increased yield under borax sprays followed by spraying of 3% urea.

Suresh and Prabha (2005) found that soil application of lime N, P and K all together *i.e.* (1% diammonium phosphate, 1% muriate of potash, 0.5% $ZnSO_4$, 0.2% $CuSO_4$ and 0.2% borax) thrice at early and late vegetative stages and inflorescence initiation stage accounted for the highest bunch yield of without expression of any iron toxicity. Higher and lower yields were obtained from boric acid (1500 ppm) and control, (15.55g and 10.82 g) respectively showed that there were no significant differences between boric acid (1500 ppm) and urea treatments on datepalm cultivar 'Shahany'.

Dutta and Banik (2007**)** noticed that the foliar application of nutrients and plant growth regulators significantly increased the fruit length, diameter, individual fruit weight and ultimately crop yield in guava (*Psidiumguajava* L.). Maximum fruit length (6.24 cm) was obtained with treatment urea + K_2SO_4 + Zinc sulphate + NAA followed by urea + K_2SO_4 + Zinc sulphate . This treatment was also found effective in maximizing individual fruit weight and crop yield. However, spraying of urea + K_2SO_4 + Zinc sulphate + GA_3 or urea + K_2SO_4 + GA_3 was also equally effective in this respect. The bio-chemical constituents were also influenced by different spraying of nutrients and growth regulators. Maximum TSS (10.85 °Brix) and total sugars (7.25%) were obtained with K_2SO_4 treatment followed by urea + K_2SO_4 + Zinc sulphate + NAA. Reduction of titratable acidity was found under NAA alone and in combination with urea + K_2SO_4 + Zinc sulphate. Tree treated with urea + K_2SO_4 + Zinc sulphate + NAA showed maximum (135.42 mg/ $s100g^1$ fruit) ascorbic acid content followed by NAA 50 ppm. The application of urea in combination with potassium sulphate, zinc sulphate and GA_3 resulted in the highest cost: benefit ratio of (1: 3.49). Therefore, it is suggested to apply urea + K_2SO_4 + Zinc sulphate + NAA for their beneficial effects on yield and qualities of fruits and also to offer better return to the growers.

Lone (2007) reported that apple trees received combined treatments of Calcium Chloride and Boron on apple trees responded to yields of apple. Application of Boron @ 0.1% as foliar spray was observed to be best treatment.

Saroliaet al. (2007) discussed the effect of foliar application of 0.3, 0.4 and 0.5 per cent Zinc Sulphate and Ferrous Sulphate with their possible combinations. The control trees were sprayed with water alone. It was observed that the maximum mean shoot length (26.05) and number of leaves (20.65) per shoot were recorded at 0.5 per cent ZnSO4 spray. The shoot length under 0.5 per cent ZnSO4 was 16.22 per cent more over control.

Pal *et al*. (2008) evaluated the effect of foliar application of nutrients on the yield.Treatments comprised: urea at 1.0 or 2.0%; K2SO4 at 1.0 or 0.5%; borax at 0.2 or 0.1%; ZnSO4 0.4 or 0.2%; and a control. Guava yield was maximum under 2.0% urea, which was closely followed by 1.0% urea.

Awasthi and Lal (2009) stated that the foliar spray of calcium nitrate (1.0%, 1.5%), borax (0.2 %, 0.3 %) and zinc sulphate (1.5 %, 2.0 %) increased the fruit yield in guava cv. Sardar.

Katiyar*et al*. (2009) explained that on the basis of two years pooled data, the highest yield was observed in Urea 2 per cent+NAA 100ppm. The experiment was conducted to study the effect of nutrients and plant growth regulators on the physico-chemical characters and yield of guava cv. Allahabad Safeda. Nutrients *viz.* Urea 2%, K_2SO_4 1%, borax 0.2%, $ZnSO_4$ 0.2% and plant growth regulators *viz.* GA_3 150 ppm, Ethrel 250 ppm and NAA 100 ppm were taken for experimentation.

Singh *et al.* (2009) studied the influence of pre-harvest foliar application of Ca, B and their combinations on fruit yield of strawberry. The treatments consisted of (i) five sprays of calcium as CaCl2 (first spray was performed at the petal fall stage and later at 7 days interval), (ii) three sprays of boron as boric acid (first spray at the beginning of flowering and later at 15 day interval), (iii) combination of (i) and (ii), and (iv) plants sprayed with water served as the control. Further, pre-harvest application either of Ca or B or Ca+B could not influence the average berry weight and total fruit yield but marketable fruit yield differed significantly among the treatments. The lowest marketable fruit yield was recorded in plants under control and the highest in plants sprayed with Ca+B (20% higher compared to control).

Abdollahiet *al.* (2010) sprayed paclobutrazol (0, 100 mg l^-), boric acid (0, 150, 300 mg l^-) and zinc sulfate (0, 100, 200 mg l^-). The criteria measured was yield. Zinc (ZnSO4) had positive effect on criteria measured. Foliar application of ZnSO4 prior to flowering was recommend for increasing fruit yield of strawberry.

Kumar *et al.* (2010) reported that foliar application of zinc sulphate (1.0 per cent) + borax (1.0 per cent) increased the fruit yield of Guava cv. Pant Prabhat.

Shukla(2011) reported that application of Ca+B 0.4% had significantly lesser incidence of fruit drop (32.6%) than in the plants kept under control (2.8% and 79.2%, respectively). The maximum yield (158.6 kg/tree) was recorded with the application of calcium carbonate+borax 0.4%, while minimum was recorded under control (105.2 kg/tree). Calcium carbonate at concentration of 0.4% significantly reduced the fruit drop and increased the retention of blossom.

Yadav*et al*. (2011) reported the impact of foliar application of micronutrients and GA3 on yield of guava fruit cv. L-49. The maximum fruit retention (57.27%), fruit yield (48.63 kg/tree) and minimum fruit drop (42.23%) were recorded with foliar application of Borax-0.4% followed by zinc sulphate 0.8%.

Goswami*et al.* (2012) conducted investigation on uniform and healthy tree of guava (*Psidiumguajava* L.) cv.Sardar. Various doses of Calcium nitrate, Borax and Zinc sulphate were sprayed twice i.e. 45 and 25 days before harvesting and compared with untreated ones. Each treatment was applied on two trees and replicated thrice in a Randomized Block Design. It was observed that the size of fruit comprises length, diameter and volume were maximum in fruits collected from trees sprayed with (Zinc sulphate 0.4%) The maximum weight was observed under 0.4% Borax and it was at par with Zinc sulphate at 0.4 per cent. The Zinc sulphate 0.4 per cent also improved the physico-chemical parameters at harvest. Among the different treatments, pre harvest spray of Zinc sulphate at 0.4 per cent was found most effective in improving the physico -chemical parameters at harvest and prolonged the shelf-life of fruits exhibiting lower degree of post-harvest losses.

Khan *et al*. (2012) investigated the influence of foliar application of boron (B) and zinc (Zn) on the productivity of *Citrus reticulata* Blanco cv. Feutrell's Early. Trees were sprayed with boric acid and zinc sulphate either alone or in combination [(T1=control (water spray), T2=0.3% boric acid at fruit set stage, T3=0.5% zinc sulphate at fruit set stage, T4=0.3% boric acid+0.5% zinc sulphate at fruit set stage, T5=0.5% zinc sulphate+0.3% boric acid at premature stage)] and the combined application of boric acid (0.3%) and zinc sulphate (0.5%) at fruit set stage effectively improved the productivity of Feutrell's Early.

Trivedi*et al.* (2012)showed the effect of different treatments of micronutrients. Maximum fruit weight (162.01g) was observed with 0.6% zinc sulphate + 0.5% boric acid followed by T_8 (0.6% zinc sulphate + 0.6% boric acid) with 154.11g while the minimum fruit weight was found under control. The higher fruit weight due to combined application of zinc sulphate and borax may be attributed to their stimulatory effect on plant metabolism. The highest polar diameter (7.91cm) was found under T_7 (0.6 per cent $ZnSO_4$ + 0.5 per cent boric acid) and minimum polar diameter (5.15 cm) was found under the control and maximum radial diameter (7.51cm) while minimum (4.62) was recorded under the control, highest yield 46.41 kg/plant under the treatment T_7 (0.6 per cent $ZnSO_4$ + 0.5 per cent boric acid), whereas minimum yield (23.71 kg/plant) was recorded under the control.

Waskela*et al*. (2013) studied the effect of micronutrients on growth, yield and quality of guava. Foliar application of zinc sulphate @ 0.75%, significantly increased the leaves per shoot (11.65), fruit length (7.06 cm), fruit width (7.09 cm), number of fruit (s) /plant (164.80), fruit weight (187.18 g), yield per plant (30.90 kg), yield per hectare (85.89 q/ha) and all the physico - chemical parameters of guava fruits over to other levels of zinc sulphate and control, followed by $ZnSO_4$ @ 0.50%. The combined spray of zinc sulphate @ 0.75% and magnesium sulphate @ 0.75% proved the best for the most of the physico - chemical and yield parameters of guava fruits, followed by zinc sulphate @ 0.75% and magnesium sulphate @ 1.0%.

Meena*et al.* (2014) made foliar applications of Calcium nitrate, Zinc sulphate and borax on 6-year-old guava cv. Lucknow- 26. They found that fruit volume (44.10 ml), fruit length (4.20 cm), fruit diameter (4.46 cm), pulp thickness (1.41 cm), reducing sugar (3.56%), non reducing sugar (2.99%), juice (78.22%), fruit weight (45.20 g), yield per tree (42.70 kg) were recorded highest with the combined spray of 3% calcium nitrate + 0.4% borax + 0.8% zinc sulphate.

Patel and Tiwari (2014) pointed out that guava fruits treated with Borax 0.5 % and 0.5 % zinc sulphate had increased the post-harvest life by 9 days over control

(25.0 %) and they were found superior in maintaining the considerable physico-chemical composition of guava fruits as compared to control.

Yadav*et al.* (2015) studied that the effect of foliar spray of micronutrients on physico-chemical characters and yield of guava fruit cv. Allahabad Safeda. The yield and quality attributes of fruits with respect to TSS, reducing sugar and total sugar, juice percent and ascorbic acid were obtained maximum with the foliar spray of zinc sulphate 0.6 % + borax 0.4%.

2.2 Quality parameters

2.2.1 Effect on physical characters

Sharma *et al.* (1991) advocated that foliar application of 0.6 per cent zinc sulphate resulted in significantly highest fruit weight (165.8 g) in guava fruit.

Bagali*et al.* (1993) reported that two spray of zinc sulphate, magnesium sulphate and boron singly and their combinations at 0.3 per cent concentration gave positive effect on physical parameters of fruits.

Dahiya*et al.*(1993) reported that foliar spray of Zinc Sulphate (0.4%) significantly increased the breadth of fruit, weight per fruit as compared to control.

Wahid *et al.* (1993) obtained the highest fruit weight (84.67g) and breadth (5.43cm) with 2% urea treatment.

Shandhu*et al*. (1994) observed that the foliar application of 0.2 per cent zinc sulphate gave maximum fruit weight in new orchard of Sand pear cv. Patharnakh.

Chaitanya*et al*. (1997) reported that foliar feeding of 0.3 per cent ZnSO4 and borax increased length and diameter of guava fruit cv. L-49.

Babu and Singh (1998) advocated that foliar application of 0.6 per cent ZnSO4 significantly increased fruit size and weight in litchi.

Raghava and Tiwari (1998) reported that the preharvest spray of borax (0.6-1%) improved the quality of guava fruits in terms of size and weight.

Kundu and Mitra (1999) reported that spray of 0.3 per cent Zn on guava trees increased weight and diameter of fruit over control. Similar findings have also been reported by singh and Brahmachari (1999).

Das *et al.* (2001) sprayed the guava trees with 0.5 or 1.0 per cent aqueous solution of Zinc Sulphate or with water (control) and reported that spray increased the weight of fruits but the specific gravity did not change much.

Kumar *et al*. (2004) advocated that foliar application of zinc (0.5%) boron (0.4%) and copper (0.5%, 1%) after flowering at pea stage significantly improved fruit length, fruit diameter and fruit weight in litchi cv. Dehradoon.

Singh *et al*. (2004) found that spray of $ZnSO_4$ (0.4%) and boric acid (0.4%) considerably increased the size and weight of guava fruits in comparison to control.

Meena*et al.* (2005) studied the combined effect of foliar application of urea (2.0, 2.5 and 3.0%) and $ZnSO_4$ (0.5, 1.0 and 1.5%) on the fruit quality and yield of pruned guava (cv. Sardar) under high-density planting system and reported that foliar application of 3.0% urea + 1.0% $ZnSO_4$ increased fruit size, weight and pulp/seed ratio.

Prasad *et al.* (2005) found that 0.8% borax significantly increased the length and diameter of guava cv. AllahbadSafeda. All the treatments increased fruit weight and yield under borax spray followed by spraying of 3% urea.

Dutta and Banik (2007) studied the effect of foliar feeding of nutrients and plant growth regulators on physico-chemical quality of guava cv.Sardar. Experimental results revealed that foliar feeding of nutrients and plant growth regulators significantly increased the fruit length, diameter and individual fruit weight. Maximum (6.24 cm) length of fruit was obtained with urea + K_2SO_4 + Zn + NAA followed by urea + K_2SO_4 + Zn. This treatment was also found effective in maximizing individual fruit weight.

Pal *et al.* (2008) evaluated the effect of foliar application of nutrients. Treatments comprised: urea at 1.0 or 2.0%; K_2SO_4 at 1.0 or 0.5%; borax at 0.2 or 0.1%; $ZnSO_4$ 0.4 or 0.2%; and a control. Fruit size, in terms of both length and breadth, was significantly increased by foliar application of nutrients. The maximum value of both characters was recorded under 2.0% urea. However, 1.0% urea was at par with 0.4% $ZnSO_4$ for increasing the fruit size. The weight and volume were maximum under 2.0% urea followed by 1.0% urea and 0.4% $ZnSO_4$. Maximum specific gravity of fruit (1.19) was observed with 1.0% urea spray.

Kumar *et al.* (2010) studied the influence ofZincSulphate and boric acid spray onwinter season guava cv. Pant Prabhat. The greatest average fruit weight (148.30 and 149.20 g, respectively), was recorded for trees sprayed with 1% Zinc Sulfate and 1% boric acid.

Khan *et al*. (2012) investigated the influence of foliar application of boron (B) and zinc (Zn), on *Citrus reticulata* Blanco cv. Feutrell's Early and found that there was a significant increase in fruit weight with application of 0.3% boric acid+0.5% zinc sulphate when sprayed at the fruit set stage.

Trivedi*et al*. (2012) evaluated the effect of zinc (Zn) and boron (B) on the yield and fruit quality of guava. The treatments comprised control (tap water; T0), 0.5% boric Acid (T1), 0.6% boric acid (T2), 0.5% zinc sulfate (T3), 0.5% zinc sulfate + 0.5% bori acid (T4), 0.5% zinc sulfate + 0.6% boric acid (T5), 0.6% zinc sulfate (T6), 0.6% zinc sulfate + 0.5% boric acid (T7) and 0.6% zinc sulfate + 0.6% boric acid (T8). Data were recorded on fruit weight and fruit diameter. It was noted that the combined foliar application of zinc sulfate (0.6%) and boric acid (0.5%) before and after fruit set resulted in higher fruit weight, radial diameter, polar diameter and specific gravity.

2.2.2 Effect on chemical characters

Sharma *et al.* (1991) advocated that foliar application of 0.6 per cent zinc sulphate resulted in significantly highest fruit total soluble solids (11.25%) and ascorbic acid (127.67 mg/100 g) with lowest (0.36%) acidity content in guava fruit.

Dahiya*et al.*(1993) reported that foliar spray of Zinc Sulphate (0.4%) significantly increased the total soluble solids as compared to control.

Shandhu*et al*. (1994) observed that the foliar application of 0.2 per cent zinc sulphate considerably reduced the acidity in new orchard of Sand pear cv. Patharnakh.

Raghava and Tiwari (1998) reported that the preharvest spray of borax (0.6-1%) improved the quality of guava fruits in terms of TSS (total soluble solids), ascorbic acid and acidity.

Kundu and Mitra (1999) reported that guava tree sprayed with 0.3 per cent Zn showed increased total soluble solids, ascorbic acid and reduced acid content in fruits.

Singh and Brahmachari (1999) reported that total soluble solids and ascorbic acid contents of the fruit pulp enhanced markedly with the application of two levels of Zinc (0.5 and 1.0 per cent $ZnSO_4$). Application of 1.0 per cent $ZnSO_4$ resulted in significant reduction in acidity in guava fruit over 0.5% $ZnSO_4$ and control. The application of boron and zinc enhanced TSS considerably. The ascorbic acid content of the fruit pulp also increased greatly with the higher concentrations of boron and Zinc.

Balakrishnan (2000) reported the effect of foliar application of micronutrients on quality of guava. Foliar spray of 1.0 per cent $ZnSO_4 7H_2O$ resulted in increase in total soluble solids and ascorbic acid over control.

Balakrishnan (2001) reported that the foliar spray of 0.5 per cent $ZnSO_4$ significantly increased total soluble solids and ascorbic acid. However the acidity remained unchanged. Among the treatments, foliar sprays of 0.25% $ZnSO_4$+0.25% $FeSO_4$+0.25% $MgSO_4$+0.1% Borax at an interval of 60 days significantly increased the fruit quality.

Bhatia *et al.* (2001) carried out an experiment on guava in which K_2SO_4 (0.5, 1.0 and 1.5%), $ZnSO_4$ (0.5, 0.75 and 1.0%), H_3BO_3 (0.3, 0.5 and 1.0) and water (control) were sprayed. The total soluble solids were more with H_3BO_3 followed by K_2SO_4 1.5%. Ascorbic acid (182g/100g) was found maximum with K_2SO_4 1.5%.

Prabu and Singaram (2001) reported the effect of Zn and B on the quality of grapes. The treatments were $ZnSO_4$ 0.5% (10 and 20 g per vine) and borax 0.2% (4 and 8 g), alone and in combinations. Foliar applications were conducted during the vegetative and full bloom stages. The TSS (15.8 degrees Brix), and sugar:acid ratio (10.84) were highest with $ZnSO_4$ + borax treatments.

Singh *et al*. (2004) noted that foliar application of boron increased TSS and ascorbic acid contents in guava fruits.

Meena*et al.* (2005) studied the combined effect of foliar application of urea (2.0, 2.5 and 3.0%) and $ZnSO_4$ (0.5, 1.0 and 1.5%) on the fruit quality of pruned guava (cv. Sardar) under high-density planting system. The greatest ascorbic acid content (148.68 mg/100 g pulp) was recorded with the foliar application of 3.0% urea + 1.0% $ZnSO_4$.

Dutta and Banik (2007) studied the effect of foliar feeding of nutrients and plant growth regulators on physico-chemical quality of guava cv. Sardar. The bio-chemical constituents were also influenced by different spraying of nutrients and growth regulators. Maximum TSS (10.85 degrees B) was obtained with K_2SO_4 treatment followed by urea + K_2SO_4 + Zn + NAA. Reduction of titratable acidity was found under NAA alone on in combination with urea + K_2SO_4 + Zn. Plants treated with urea + K2SO4 + Zn + NAA showed maximum (135.42 mg 100 g^{-1} fruit) ascorbic acid content followed by NAA 50 ppm.

Lone (2007) reported that apple trees receiving combined treatments of Calcium Chloride and Boron were observed to be better in fruit quality. Application of Boron @ 0.1% as foliar spray was observed to be the best treatment.

Singh *et al.* (2009) determined the influence of pre-harvest foliar application of Ca, B and their combinations on quality of strawberry. The treatments consisted of (i) five sprays of calcium as CaCl2 (first spray was performed at the petal fall stage and later at 7 days interval), (ii) three sprays of boron as boric acid (first spray at the beginning of flowering and later at 15 day interval), (iii) combination of (i) and (ii), and (iv) plants sprayed with water served as the control. Results indicated that fruit harvested from plants, which were sprayed either with Ca or Ca+B had average berry weight and total fruit yield. Similarly, fruit receiving Ca or Ca+B were firmer had lower TSS, higher acidity and ascorbic acid content at the time of harvest than those harvested from plants under control.

Abdollahi*et al*. (2010) sprayed paclobutrazol (0, 100 mg l^{-}), boric acid (0, 150, 300 mg l^{-}) and zinc sulfate (0, 100, 200 mg l^{-}) on selva strawberry cultivar. The criteria measured were total soluble solids, acidity and vitamin C. Zinc (ZnSO4) had positive effect on criteria measured. Foliar application of ZnSO4 prior to flowering was recommend to increase the fruit quality of strawberry.

Shukla (2011) examined the impact of pre-harvest foliar application of Ca (as calcium carbonate), B (as borax) individually and their combinations. Treatments consisted of Ca as CaCO3 at 0.2%, 0.4%, 0.6%, boron as borax at 0.2%, 0.4% 0.6%, Ca+B (mixed) 0.2%, 0.4%, 0.6% and plants sprayed with water served as the control. In totality all the treatments increased quality of fruits as compared to control. The maximum vitamin C (626.49 mg/100 g) was recorded with calcium carbonate+borax 0.4%. Similarly, it was also observed that such fruit (sprayed with Ca+B 0.4%) had slightly higher TSS (16.5%) at harvest than those in control (15.1%).

Khan *et al*. (2012) investigated the influence of foliar application of boron (B) and zinc (Zn), on the fruit quality of *Citrus reticulata* Blanco cv. Feutrell's Early and reported that application of 0.3% boric acid+0.5% zinc sulphate at pre-mature stage significantly enhanced the concentration of ascorbic in the Feutrell's Early fruit juice. In conclusion, the combined application of boric acid (0.3%) and zinc sulphate (0.5%) at fruit set stage effectively improved the fruit quality of Feutrell'searly madarin.

Trivedi*et al. (*2012) evaluated the effect of zinc (Zn) and boron (B) fertilizers on the fruit quality of guava. The treatments comprised control (tap water; T0), 0.5% boric Acid (T1), 0.6% boric acid (T2), 0.5% zinc sulfate (T3), 0.5% zinc sulfate + 0.5% boric acid (T4), 0.5% zinc sulfate + 0.6% boric acid (T5), 0.6% zinc sulfate (T6), 0.6% zinc sulfate + 0.5% boric acid (T7) and 0.6% zinc sulfate + 0.6% boric acid (T8). Data were recorded on total soluble solids (TSS), titratable acidity and ascorbic acid content. It was shown that that the combined foliar application of zinc sulfate (0.6%) and boric acid (0.5%) before and after fruit set resulted in higher TSS, acidity, ascorbic acid, and sugar-acid ratio.

2.2.3 Effect on organoleptic parameter

Bhatia *et al.* (2001) carried out studies on guava in which K_2SO_4 (0.5,1.0 and 1.5%),$ZnSO_4$(0.5,0.75 and 1.0%),H_3BO_3(0.3,0.5 and 1.0) and water (control) were sprayed on the trees during winter season crop at the stage when the fruit was of walnut size (25th of October) and second after 15 days.All the nutrients increased fruit weight and yield which was maximum (73.0kg per tree) with H_3BO_3 1.0%.The fruit pressure was minimum (10.1kg/cm2) with H_3BO_3 at 1.0%.The organoleptic rating out of 10 points was the highest (9.0) with K_2SO_4 at 1.5%.The total soluble solids and sugars were more with H_3BO_3 followed by K_2SO_4.Ascorbic acid was found maximum with K_3SO_4(182gm/100g).

2.2.4 Effect on post harvest parameters

Kumar and Brahmachari (2006) reported that pre harvest application of different chemicals significantly reduced physiological loss in weight of fruit during stored. Spray of GA_3 200 ppm followed by $CaCl_2$ 2.0 per cent and Kinetin 50 ppm was most effective treatment in minimizing the physiological loos in weight.

No *et al.* (2007) focused on the application of chitoson for improvement of qualityand shelf life of various foods from agriculture, poultry and seafood origin.

Rajput *et al.* (2008)reported that pre harvest spray of 2.0 per cent calcium nitrate was improve the shelf life guava cv. Gwaliar-27

Sanjay *et al.* (2008)concluded that the anola fruit treated with GA_3 100 ppm or calcium nitrate 1.5 per cent and kept in perforated polythene bags could efficiently rate in the fruit quality till the last day of storage (13th days) under ambient temperature.

Economic analysis

Wahid *et al.* (1993) obtained the highest cost benefit ratio (1:9.58) with 2% ureatreatment, followed by 0.2% borax treatment (1:6.35).

Dutta and Banik (2007) reported the highest cost:benefit ratio of 1:34.92 with the spraying of urea + K2SO4 + Zn + NAA followed by 1:34.06 with urea application alone.

Chapter III

MATERIAL AND METHODS

The present investigation entitled "**Effect of foliar application of borax and zinc sulphate on growth, yield and quality of guava (*Psidium guajava* L.) cv. Gwalior-27**" was carried outat Agrotechnology Park, Krishi Vigyan Kendra, College of Agriculture, Gwalior (M.P.) during 2016-2017**.**This chapter narrates the details of procedure adopted and materials used during the experimentation.

3.1 Experimental site

The experiment was conducted at Agrotechnology Park of Krishi Vigyan Kendra, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during 2016-2017.

3.2 Climatic Conditions

Gwalior is situated at 26^0 $13^{'}$ N latitude and 78^0 14' E longitudes at an altitude of 211.5 m above mean sea level in Gird belt. It has a subtropical climate with hot and dry summer where maximum temperature exceeds 45.3^0 C in May (14-20). The winters are cold and minimum temperature reaches as low as 6.4^0 C in December (17-23). Frost is expected from the last week of December. Usually the monsoon arrives in the second fortnight of June and last till September.

The meteorological data such as maximum and minimum temperature (45.3^0C to 6.4^0 C), Relative humidity (98.3 to 12.8), rainfall (121.0 mm to 000.0 mm) and Evaporation (13.5 to 0.8)were recorded during experimental period and are presented in Table 3.1 and graphically represented in Fig 3.1.

Table 3.1: Meteorological data during crop season 2016

Met. Week	Date	Temperature (° C)		Humidity (%)		Rainfall (mm)	Evaporation (mm)
		Max.	Min.	Morning	Evening		
19	May 7-13	39.9	25.3	53.4	23.7	000.0	11.1
20	May 14-20	45.3	27.6	39.4	16.2	000.0	13.5
21	May 21-27	42.2	28.3	53.7	28.7	021.2	11.4
22	May-June 28-3	41.9	27.7	55.8	27.4	000.0	10.5
23	June 4-10	44.6	28.8	47.1	23.4	007.0	12
24	June 11-17	41.6	28.6	52.1	33.4	004.0	11.0
25	June 18-24	38.1	28.5	69.1	28.5	022.0	7.1
26	June-July 25-1	39.6	29.1	71.4	43.0	002.8	7.1
27	July 2-8	35.3	27.3	81.0	65.8	051.0	5.0
28	July 9-15	33.8	27.1	88.5	77.8	020.6	2.9
29	July 16-22	33.1	26.6	81.2	64.7	029.2	4.1
30	July 23-29	34.2	25.9	90.5	76.5	121.0	4.4
31	July- Aug. 30-5	32.0	25.0	94.8	73.1	118.0	1.5
32	Aug. 6-12	32.4	25.6	92.4	76.0	081.2	2.8
33	Aug. 13-19	32.1	25.5	90.2	73.5	065.0	2.2
34	Aug. 20-26	30.9	24.5	88.7	70.8	024.0	3.2
35	Aug.-Sept. 27-2	34.0	26.0	88.7	70.8	010.0	3.8
36	Sept. 3-9	33.4	25.6	74.1	57.7	001.0	5.8
37	Sept. 10-16	34.6	25.9	78.4	55.2	000.0	4.4
38	Sept. 17-23	35.0	24.8	89.0	61.0	009.2	4.3
39	Sept. 24-30	34.6	23.7	85.8	50.1	000.0	4.6
40	Oct. 1-7	35.0	25.1	87.0	56.5	014.0	3.5
41	Oct. 8-14	35.6	21.1	65.6	29.8	000.0	5.0
42	Oct. 15-21	35.2	16.2	80.1	22.6	000.0	4.7
43	Oct. 22-28	35.0	17.1	69.7	24.0	000.0	5.4
44	Oct.–Nov.29-4	32.1	13.5	92.1	29.4	000.0	2.4
45	Nov.5-11	31.5	11.8	85.8	23.2	000.0	3.5
46	Nov.12-18	30.9	10.3	87.8	28.0	000.0	2.4
47	Nov. 19-25	29.9	9.5	84.7	27.7	000.0	2.6
48	Nov.–Dec.26-2	28.8	11.0	79.8	35.4	000.0	3.6
49	Dec.3-9	26.0	8.3	98.3	50.0	000.0	1.0
50	Dec.10-16	27.2	8.9	90.8	37.8	000.0	1.8
51	Dec.17-23	25.7	6.7	86.5	38.4	000.0	2.3
52	Dec.24-31	25.7	7.44	88.7	43.3	000.0	1.8

Source:Meteorological Observatory, College of Agriculture, Gwalior (M.P).

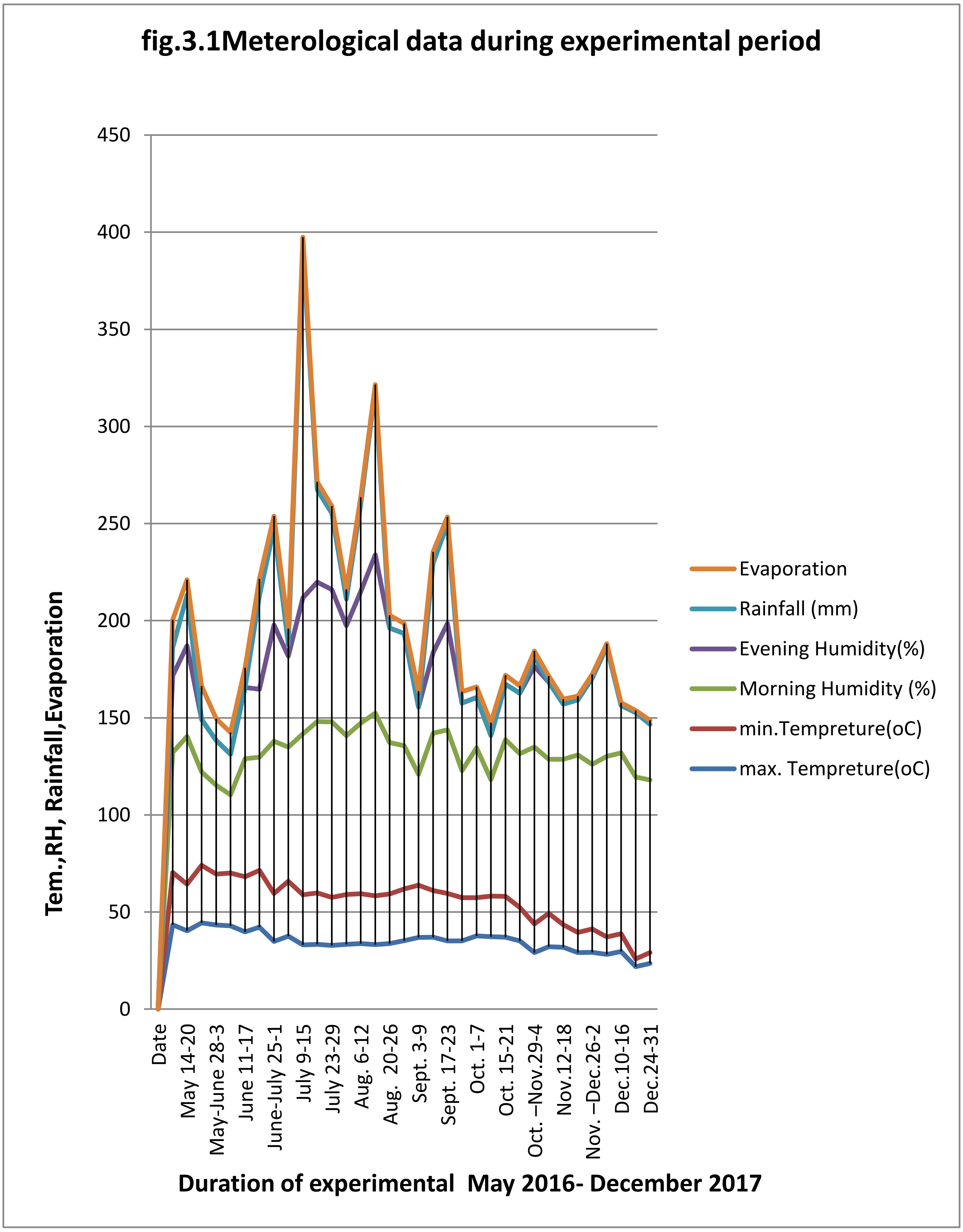


fig.3.1Meterological data during experimental period
450
400
350
300
250
200
150
100
50
0
Tem.,RH, Rainfall,Evaporation
Date
May 14-20
May-June 28-3
June 11-17
June-July 25-1
July 9-15
July 23-29
Aug. 6-12
Aug. 20-26
Sept. 3-9
Sept. 17-23
Oct. 1-7
Oct. 15-21
Oct. –Nov.29-4
Nov.12-18
Nov. –Dec.26-2
Dec.10-16
Dec.24-31
Duration of experimental May 2016- December 2017
Evaporation
Rainfall (mm)
Evening Humidity(%)
Morning Humidity (%)
min.Tempreture(oC)
max. Tempreture(oC)

3.3 Experimental materials

The investigation was conducted on 7 years old guava plants planted at 6 X 6 m apart under square system of planting. In order to assess the effects of various treatments, all the plants were subjected to uniform cultural practices during the period of experimentation.

3.4 Experimental details

The experiment was laid out in Randomized Block Design with three replications with a unit of one plant in each replication of a treatment.

Symbol	**Details of the treatment**
T1	Control (Water spray)
T2	Borax(0.2%)
T3	Borax (0.4%)
T4	ZnSO4 (0.4%)
T5	ZnSO4 (0.6%)
T6	Borax (0.2%)+ZnSO4 (0.4%)
T7	Borax (0.2%) + ZnSO4 (0.6%))
T8	Borax (0.4%) + $ZnSO_4$ (0.4%)
T9	Borax (0.4%)+ Znso4 (0.6%))

3.5 Experimental design and layout

- Name of crop : Guava (*Psidium guajava* L.)
- Name of cultivar : Gwalior 27
- Number of treatments : 9
- Design : Randomized Block Design
- Number of plants per treatment : 01
- Number of replications : 03
- Total number of plant : 27
- Age of plans : 7 years
- Plants spacing : 6 m x 6 m
- Time of spray : first spray one month after fruit set and second after two month of fruit setting.

3.6 Preparation of solution

The stock solution of different concentrations of zinc sulphate (neutralized with hydrated lime) and borax were prepared by dissolving the required amount of zinc sulphate and boric acid in required amount of water.

3.7 ObservationsRecorded

Observations on various characters of plant *i.e.* growth, fruiting, yield, physical and chemical attributes of fruits and economics of different treatments applied were worked out as per standard procedures.

List of observations

A.Growth parameter

1. Shoot length (cm)
2. Shoot diameter (cm)
3. Number of leaves per shoot

B. Yield attributes

1. Number of fruit per plant
2. Average fruit weight (g)
3. Yield of fruit per plant (kg)
4. Yield (q/ha)

5. Polar diameter of fruit (cm)
6. Radial diameter of fruit (cm)
7. Pulp weight (g)
8. Seed weight (g)

C. Bio - chemical analysis of fruits

1. Acidity (%)
2. Total Soluble Solids (^{0}Brix)

D.Organoleptic parameters

1. Taste
2. Colour and appearance
3. Aroma
4. Over all acceptability

E. Post harvest parameters

1. PLW%
2. Fruit spoilage %
3. Shelf life (days)

3.7.1 Growth parameters

3.7.1.1 shoot length (cm)

Five newly emerged tertiary shoot of uniform length were selected and tagged in each treatment. The initial length of tagged shoot was measured with the help of meter scale at the time of treatment application. Then periodical lengths of shoots were measured at 15 days interval for a period of two months. The per cent increase in length of shoot was calculated on the basis of initial length of shoot on each 15 days interval of observations.

3.7.1.2 Shoot diameter (cm)

For measuring the diameter of shoot, a mark was put on the second internodes of the selected shoots. The initial diameter of shoot was measured by vernier caliper at the time of treatment application. Then periodical observation on shoot diameter was recorded at 15 days interval for a period of two months. The per cent increase in diameter was calculated on the basis of initial shoot diameter.

3.7.1.3 Number of leaves per shoot

The leaves were counted on each selected shoot and the average leaf number per shoot was calculated.

3.7.2 Yield attributes

The yield and yield contributing characters of guava were recorded after the picking of mature fruits of each plant.

3.7.2.1 Number of fruits per plant

The number of fruits per plant was recorded separately for each plant at each picking.

3.7.2.2 Average fruit weight (g)

The average weight of fruit was calculated after the final picking as per the formula given below

Average fruit weight = Total weight of fruits (g)/ Number of fruits

3.7.2.3 Yield of fruit per plant (kg)

The fruit of each plant were weighed separately by top pan balance and recorded at each picking.

3.7.2.4 yield (q/ha)

The weight of fruits per tree was recorded at every harvest and total yield (q) per hectare was calculated at the final harvest.

3.7.2.5 Polar diameter of Fruit (cm)

Polar diameter of fruit was measured from upper pole to lower pole ends of the fruit and expressed in centi meters at harvest with the help of Vernier Calliper.

3.7.2.6 Radial diameter of Fruit (cm)

The radial diameter of the fruit was measured at the centre of the fruit with the help of Vernier Calliper and expressed in cm.

3.7.2.7 Pulp weight (g)

To calculate pulp weight of fruit, the seed weight was substracted from total weight of fruit.

3.7.2.8 Seed weight (g)

To calculate seed weight of fruit, seeds extracted from fruit were weighed with the help of electronic balance and expressed in gram.

3.7.3 Bio-chemical analysis of fruit

For determination of fruit quality, four healthy fruits were selected randomly from each tree at full maturity stage. The fruits were washed thoroughly before analysis for the following contents.

3.7.3.1 Acidity (%)

Acidity was estimated by simple acid–alkali titration method as described in Association of analytical chemist (1970). Firstly 20 ml fruit juice solution was taken by pipette and transferred into a 100 ml flask and then distilled water was added to make up the volume up to 100 ml. It was shaken well to dissolve. 0.25 ml of diluted fruit juice was taken by pipette and transferred into a 250 ml beaker, then 3 drops of Phenophthalene indicator were added in this solution. The burette was filled with N/10 NaOH solution and juice was titrated with alkali solution, drop by drop with constant stirring till the pink end point was reached. End point readings were recorded and the percentage acidity was calculated by the formula and expressed in terms of citric acid.

$$\text{Total acidity per cent} = 0.128 \times \text{titer value}$$

3.7.3.2 Total soluble solids (^{0}Brix)

Sampled fruits of each plant were crushed to form a homogenized pulp and then the juice was extracted through muslin cloth. The extract was used for determination of T.S.S. in ^{0}Brix by digital refractometer. Only 2-3 drops of juice were placed on the surface of refrectometer and the reading was recorded directly.

3.7.4 Organoleptic parameter

The samples were evaluated from the organoleptic qualities on the score card called hedonic scale. The quality parametres were quantified for different fruit grades and mean score of 10 judges was calculated, and used for further interpretations.

Organoleptic evaluation by 10 panelist was carried out using a nine-point hedonic scale (1=dislike extremely, 10 like extremely) water was also provided for the testers to rinse their month after each evaluation under a well lighted room.

3.7.4.1 Taste

The taste of guava fruit was judged by testing method. For this panel of 10 judges was chosen who examined the taste of fruit and score given by them was averaged.

Table: 1 Sensory score for taste of guava fruit.

Taste	**Sensory scale**
Very tasty	7.5 - 10.00
Tasty	5.0 - 7.49
Moderate tasty	2.5 - 4.99
Not tasty	< 2.50

3.7.4.2 Colour and appearance

The colour of guava fruit was judged by visual method. For this panel of 10 judges was chosen who examined the colour of fruit and score given by them was averaged.

The scoring was done by following pattern.

Table:2 Sensory score for colour and appearance of guava fruit.

Colour	**Sensory scale**
Yellow colour	7.5 - 10.00
Light green	5.0 - 7.49
Dark green	2.5 - 4.99

Green	< 2.50

3.7.4.3 Aroma

The aroma of guava fruit was judged by smelling method. For this panel of 10 judges was chosen who examined the aroma of fruit and score given by them was averaged.

Table:3 Sensory score for aroma of guava fruit.

Aroma	**Sensory scale**
Highly aromatic	7.5 - 10.00
Aromatic	5.0 - 7.49
Poorly aromatic	2.5 - 4.99
Not aromatic	< 2.50

3.7.4.4 Overall acceptability

The overall acceptability of guava fruit was judged by a panel of six judged according to colour, taste and aroma of fruit and score given by them was average.

Table:4 Sensory score for over all acceptability of guava fruit.

Over all acceptability	**Sensory scale**
Highly acceptable	7.5 - 10.00
Acceptable	5.0 - 7.49
Poorly acceptable	2.5 - 4.99
Not acceptable	< 2.50

3.7.5 Post harvest parameters

3.7.5.1 Physiological loss in weight (%)

For determination of physiological loss in weight, ten fruits were selected and five fruit were marked in each unit. They were weighed prior to the storage treatment and then subsequently at five days intervals. The loss in weight was expressed on percentage basis.

$$\text{PLW \%} = \frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

3.7.5.2 Fruit spoilage (%)

For determination of fruit spoilage percent, ten fruits were selected and five fruits were marked in each unit. decayed fruits were counted every 5^{th} day and expressed on percentage basis.

$$\text{Spoilage\%} = \frac{\text{Spoiled fruit number}}{\text{Total fruit number}} \times 100$$

3.7.5.3 Shelf life (days)

The when fruit of second lot showed shrinkage and brown to black spot appear on fruitsurface at end of storage, the duration in days between the ripe and end of storage was taken as self life of fruit and expressed in days.

3.8 Economics of treatments

The cost of cultivation per hectare under different treatments was calculated on the basis of expenditure incurred with respect to item wise operations for maintaining the crop separately under each treatment. The treatment wise net income was worked out by deducting the cost of cultivation from gross income per hectare. The cost: benefit ratio was also calculated.

3.9 Statistical analysis

The skeleton of ANOVA as per design is given in table 5. The standard error and critical difference were calculated.The significance of the treatment judged by using critical difference (C.D.).

The data obtained from set of observation for each character were subjected to “Analysis of Variance” as advocated by Panse and Sukhatme (1985). The Skeleton of ANOVA as per design is as given in Table 3.5

Table 3.9.1: Skeleton of analysis of variance

Source of variation	Degree of freedom	Sum of square	Mean sum of square	"F" Value Calculated	"F" tab. $at_{5\%}$	"t" $at_{5\%}$
Replications	2	SSR	MSR			
Treatment	8	SST	MST			
Borax levels	2	SSB	MSB	MSB/MSE		
(B)	2	SSZn	MSZn	MSZn/MSE		
ZnSo4 levels	4	SS(BXZ	MS(BXZn	MS(BXZn)/M		
(Zn) B x Zn	16	n)	)	SE		
Error	26	SSE	MSE			
Total						

The significance of the treatment difference was judged by using critical difference (C.D.), which was calculated by using formula given by Panse and Sukhatme (1985).

(i) C.D. for Borax levels

$$= \sqrt{\frac{2EMS}{9}} \times t_{16df}$$

(ii) C.D. for Zinc sulphate levels

$$= \sqrt{\frac{2EMS}{9}} \times t_{16df}$$

(iii) C.D. for Interaction (BXZn)

$$= \sqrt{\frac{2EMS}{3}} \times t_{16df}$$

Chapter – IV
RESULTS

An investigation entitled **"Effect of foliar spray of borax and zinc sulphate on growth, yield and quality of guava (*Psidiumguajava*L.) cv. Gwalior-27"** was carried out at Agrotechnology Park, Krishi Vigyan Kendra, College of Agriculture, Gwalior (M.P.) during 2016-2017**.**

The results obtained during the course of investigation have been described in this chapter under appropriate headings. The Analysis of variance for the various characters has been appended for reference in appendices. The observations are summarized in the form of Tables (4.1 to 4.20) & illustrated through figures (Figures 4.1a to 4.20 b) wherever found necessary.

4.1 Growth Parameter

The data pertaining to various vegetative parameters of the guava plant viz., shoot length, shoot diameter and number of leaves per shoot are given in Table 4.1 to 4.3 and Figures 4.1a to 4.3b. The analysis of variance for the same is given in appendices I to III.

4.1.1 Shoot length (cm)

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the tertiary shoot length are presented in Table 4.1 and Figures 4.1a to 4.1b. The analysis of variance for same is given in appendix I.

4.1.1.1 Effect of Borax

The tertiary shoot length significantly increased due to the spray of Borax over the control. The mean maximum tertiary shoot length (6.43 cm) was recorded under the treatment B_2 (Borax @ 0.4%). Significant differences were observed under B2 and B_1 (Borax @ 0.4% and Borax @ 0.2%) respectively, while the minimum shoot length (5.34 cm) was recorded under control (B_0).

4.1.1.2 Effect of Zinc sulphate

Tertiary shoot length was significantly affected with the spray of Zinc sulphate over the control. The mean maximum shoot length (7.19 cm) was recorded under the treatment Z_2 (ZnSo4@ 0.6 %) followed by Z_1(ZnSo4 @ 0.4%), while minimum tertiary shoot length (4.26 cm) was recorded under control (Z_0).

Table 4.1: Effect of foliar spray of Borax, Zinc sulphate and their interaction on tertiary shoot length (cm)

Zinc sulphate	Borax			Mean
	B_0	**B_1**	**B_2**	
Z_0	3.70	4.36	4.71	**4.26**
Z_1	5.82	5.94	6.49	**6.08**
Z_2	6.49	7.01	8.08	**7.19**
Mean	**5.34**	**5.77**	**6.43**	**5.84**

	Borax	**ZnSo4**	**B X Z**
S.Em.±	**0.034**	**0.034**	**0.058**
CD at 5% level	**0.101**	**0.101**	**NS**

4.1.1.3 Interaction effect of Borax and Zinc sulphate

Tertiary shoot length was non-significantly influenced due to combined spray of Borax and Zinc sulphate over the control. The maximum shoot length (8.08cm) was recorded under B_2Z_2 (Borax @ 0.4% & ZnSo4@ 0.6 %) followed by B_1Z_2 (Borax @ 0.2% & ZnSo4 @ 0.6%) while the minimum (3.7 cm) under the control (B_0 Z_0).

4.1.2 Shoot diameter (cm)

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the tertiary shoot length are presented in Table 4.2 and Figures 4.2a to 4.2b. The analysis of variance for same given in appendix II.

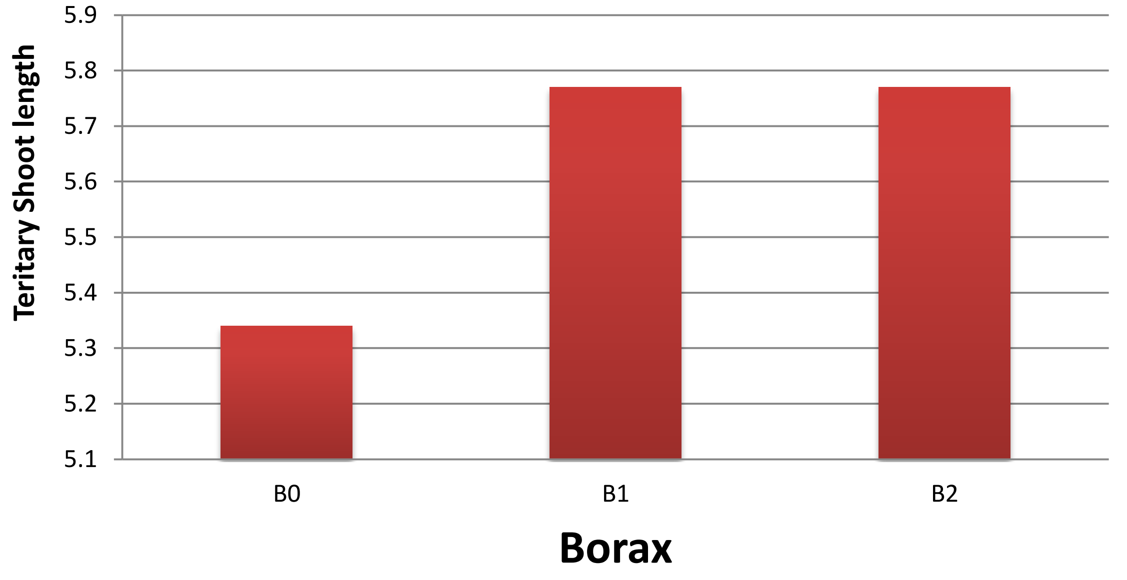
4.1.2.1 Effect of Borax

The shoot diameter was significantly increased by the spray of Borax over the control. The mean maximum tertiary shoot diameter (0.34 cm) was recorded under the treatment B_2 (Borax @ 0.4%). Significant differences were observed under B2 and B_1 (Borax @ 0.4% and Borax @ 0.2%) respectively, while the minimum shoot diameter (0.33 cm) was recorded under control (B_0).

4.1.2.2 Effect of Zinc sulphate

The shoot diameter was significantly increased by the spray of Zinc sulphate over the control. The mean maximum shoot diameter (0.36 cm) was recorded under Z_2 (ZnSo4 @ 0.6%) which was significantly superior to the other levels of Zinc sulphate Z_1(ZnSo4@ 0.4%), while the minimum shoot diameter (0.33cm) was recorded in control (Z_0).

Figure 4.1 a: Effect of foliar spray of Borax on Tertiary shoot length (cm)



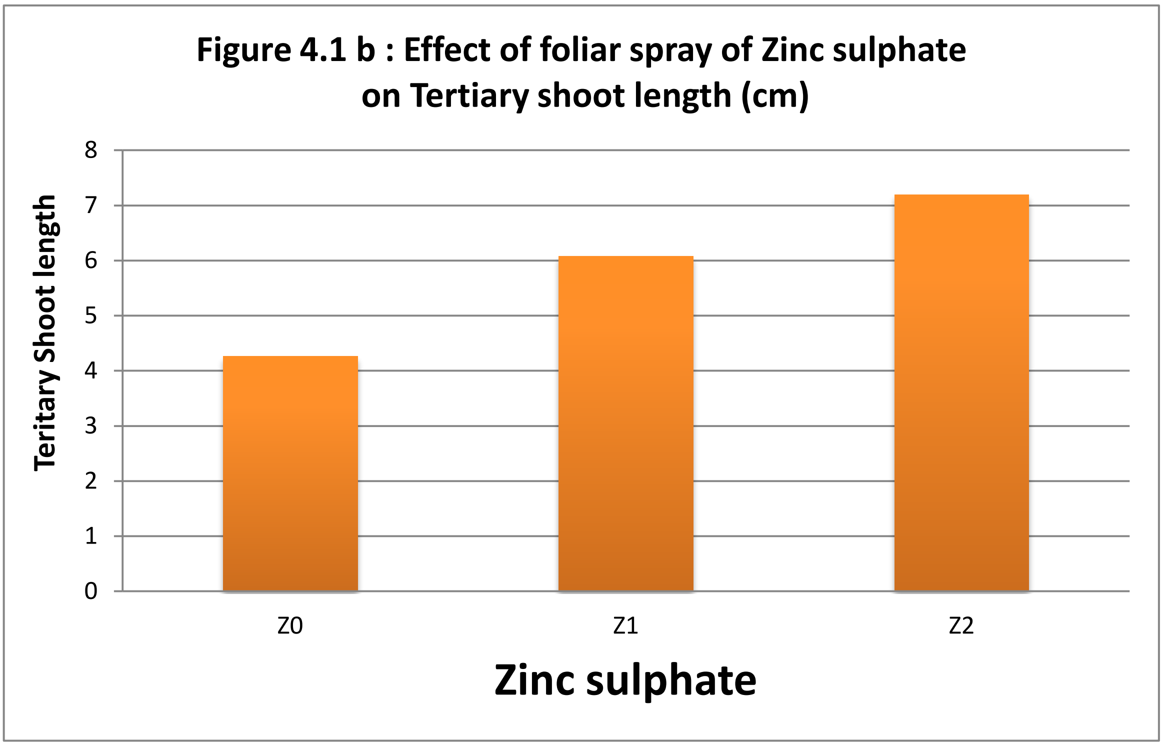


Table 4.2: Effect of foliar spray of Borax, Zinc sulphate and their interaction on tertiary shoot diameter (cm)

Zinc sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	0.33	0.34	0.31	**0.33**
Z_1	0.34	0.34	0.33	**0.34**
Z_2	0.34	0.35	0.38	**0.36**
Mean	**0.33**	**0.34**	**0.34**	**0.34**

	Borax	ZnSo4	B X Z
S.Em.±	0.005	0.005	0.009
CD at 5% level	0.016	0.016	0.028

4.1.2.3 Interaction effect of Borax and Zinc sulphate

The interaction effect of on Borax and zinc sulphate on shoot diameter was non- significantly superior over the control. The maximum shoot diameter (0.38

cm) was recorded under treatment B_2Z_2 (Borax @ 0.4% & ZnSo4@ 0.6 %), whereas the minimum (0.31 cm) under the control (B_0 Z_0).

4.1.3 Number of leaves per shoot

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the no. of leaves are presented in Table 4.3 and Figures 4.3a to 4.3b. The analysis of variance for same is given in appendix III.

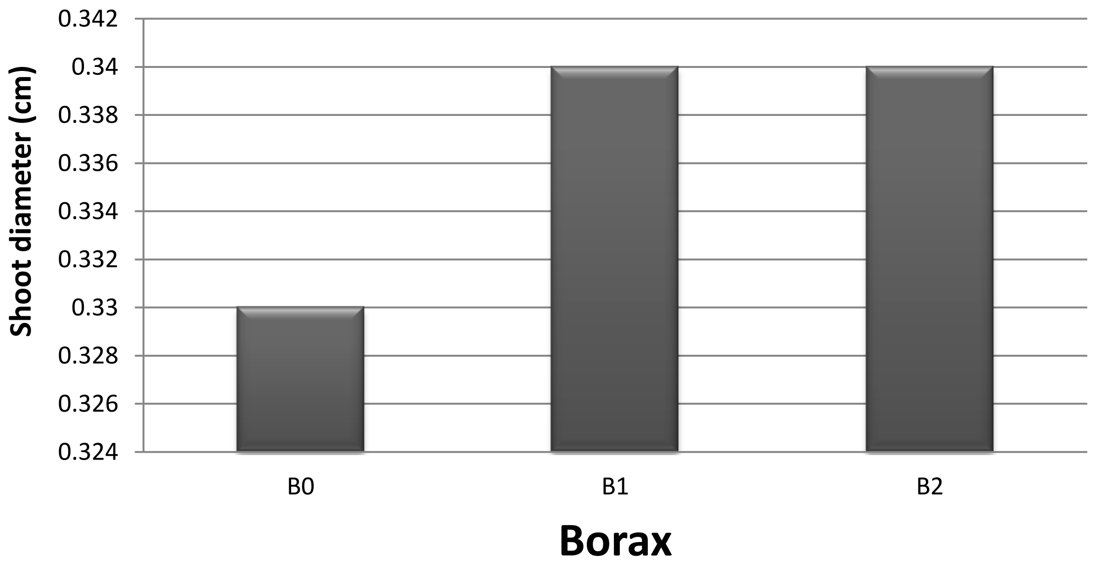
4.1.3.1 Effect of Borax

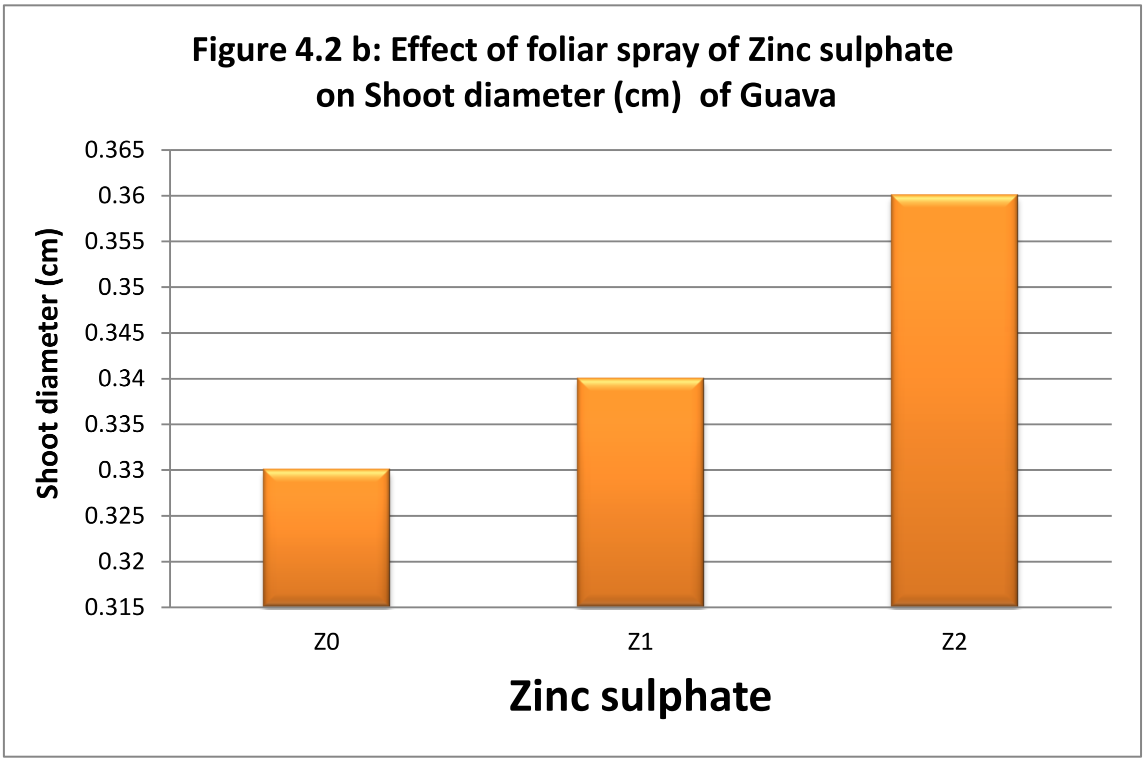
The number of leaves per shoot was significantly increased by the spray of Borax over the control. The mean maximum number of leaves per shoot (24.77) was recorded under the treatment B_2 (Borax @ 0.4%).followed by B_1 (Borax @0.2%) , while the minimum number of leaves per shoot (19.53) was recorded under control (B_0).

4.1.3.2 Effect of Zinc sulphate

The number of leaves per shoot was significantly increased by the spray of Zinc sulphate over the control. The mean maximum number of leaves per shoot (23.78) was recorded under the treatment Z_2 (ZnSo4 @ 0.6%) followed by Z_1(ZnSo4@ 0.4%), while minimum number of leaves per shoot (18.94) was recorded under control (Z_0).

Figure 4.2 a: Effect of foliar spray of Borax on Shoot diameter (cm) of Guava





4.1.3.3 Interaction effect of Borax and Zinc sulphate

Number of leaves per shoot was non-significantly influenced due to combined spray of Borax and Zinc sulphate over the control. whereas, the mean maximum number of leaves per shoot (26.30) was recorded under B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6 %) followed by B_2Z_1(Borax @ 0.4% & Znso4 @ 0.4%) while the minimum number of leaves per shoot (15.65) under the control (B_0 Z_0).

Table 4.3: Effect of foliar spray of Borax, Zinc sulphate and their interaction on number of leaves per shoot

Zinc sulphate	Borax			Mean
	B_0	**B_1**	**B_2**	
Z_0	15.65	17.68	23.50	**18.94**
Z_1	20.24	19.50	24.50	**21.41**
Z_2	22.70	22.33	26.30	**23.78**
Mean	**19.53**	**19.84**	**24.77**	**21.38**

	Borax	Zinc sulphate	B X Z
S.Em.±	0.116	0.116	0.202
CD at 5% level	0.349	0.349	NS

4.2 Yield attributes:

The data pertaining to various yield attributing parameters of the guava plant viz., number of fruits per plant, average fruit weight , yield of fruit per plant and yield per hectare,pollar diameter of fruit,radial diameter of fruit,pulpweight,seed weight are given in Tables 4.4 to 4.11 and Figures 4.4a to 4.11b. The analysis of variance for the same is given in appendices IV to XI.

4.2.1 Number of fruits per plant

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the number of fruits per plant are presented in Table 4.4 and Figures 4.4a to 4.4b. The analysis of variance for same is given in appendix IV.

4.2.1.1 Effect of Borax

The number of fruit per plant was significantly influenced by the foliar spray of Borax over the control. The maximum number of fruits per plant (67.80) was recorded with the foliar application of B2 (Borax@ 0.4%). Significant differences were observed under B2 and B1(Borax @ 0.4% and Borax @ 0.2%) respectively, while the minimum number of fruits per plant (62.40) was recorded under control (B_0).

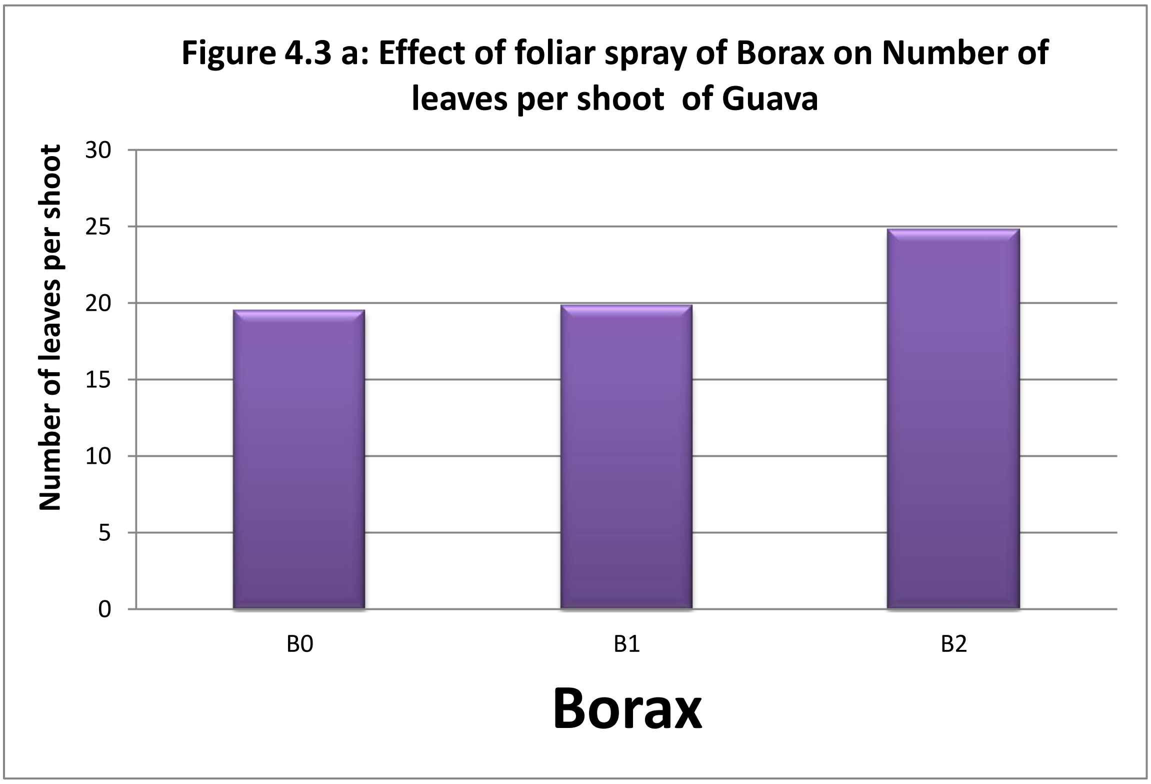


Figure 4.3 a: Effect of foliar spray of Borax on Number of leaves per shoot of Guava
Number of leaves per shoot
0
5
10
15
20
25
30
B0
B1
B2
Borax

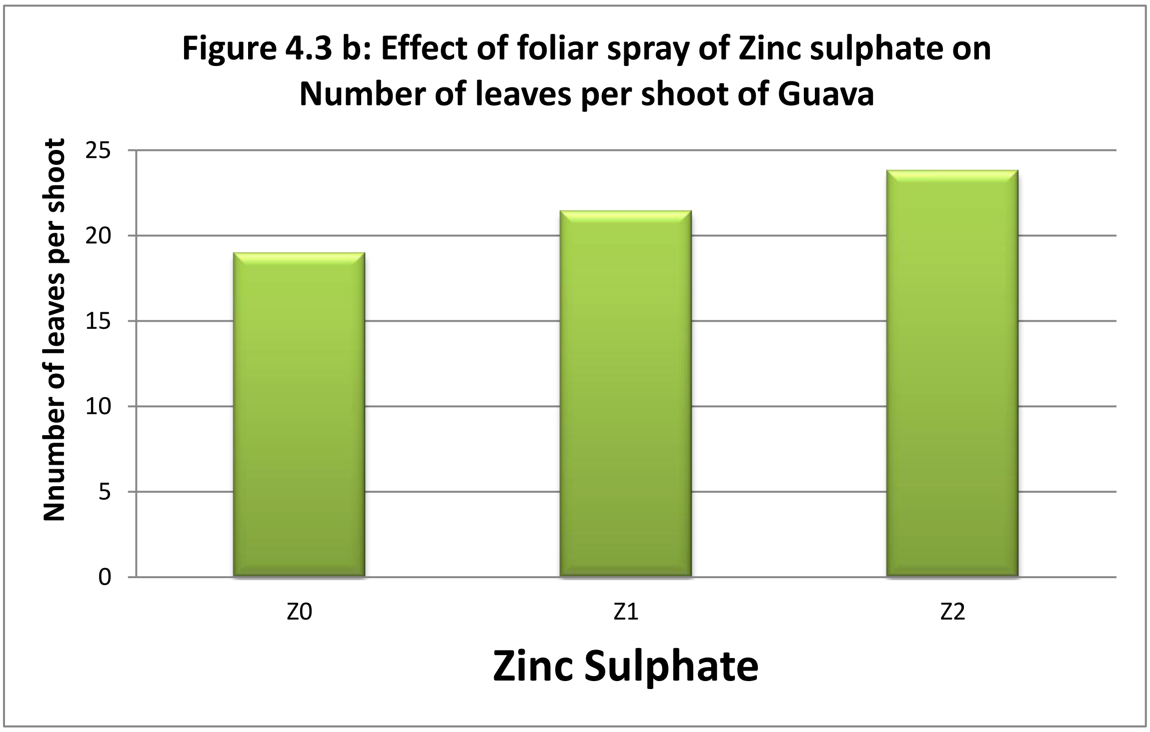


Figure 4.3 b: Effect of foliar spray of Zinc sulphate on Number of leaves per shoot of Guava
Nnumber of leaves per shoot
0
5
10
15
20
25
Z0
Z1
Z2
Zinc Sulphate

4.2.1.2 Effect of Zinc sulphate

The number of fruit per plant was significantly increased with the spray of Zinc sulphate over the control. The mean maximum (67.47) number of fruits per plant was recorded under the treatment Z_2 (ZnSo4 @ 0.6%) followed by Z_1(ZnSo4 @ 0.4%), while minimum number of fruits per plant (62.78) was recorded under control (Z_0).

Table 4.4: Effect of foliar spray of Boroax, Zinc sulphate and their interaction on number of fruits per plant

Zinc sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	59.80	63.35	65.20	**62.78**
Z_1	63.13	66.35	68.20	**65.89**
Z_2	64.27	68.16	70.00	**67.47**
Mean	**62.40**	**65.95**	**67.80**	**65.38**

	Borax	ZnSo4	B X Z
S.Em.±	**0.944**	**0.944**	**1.635**
CD at 5% level	**2.830**	**2.830**	**NS**

4.2.1.3 Interaction effect of Borax and Zinc sulphate

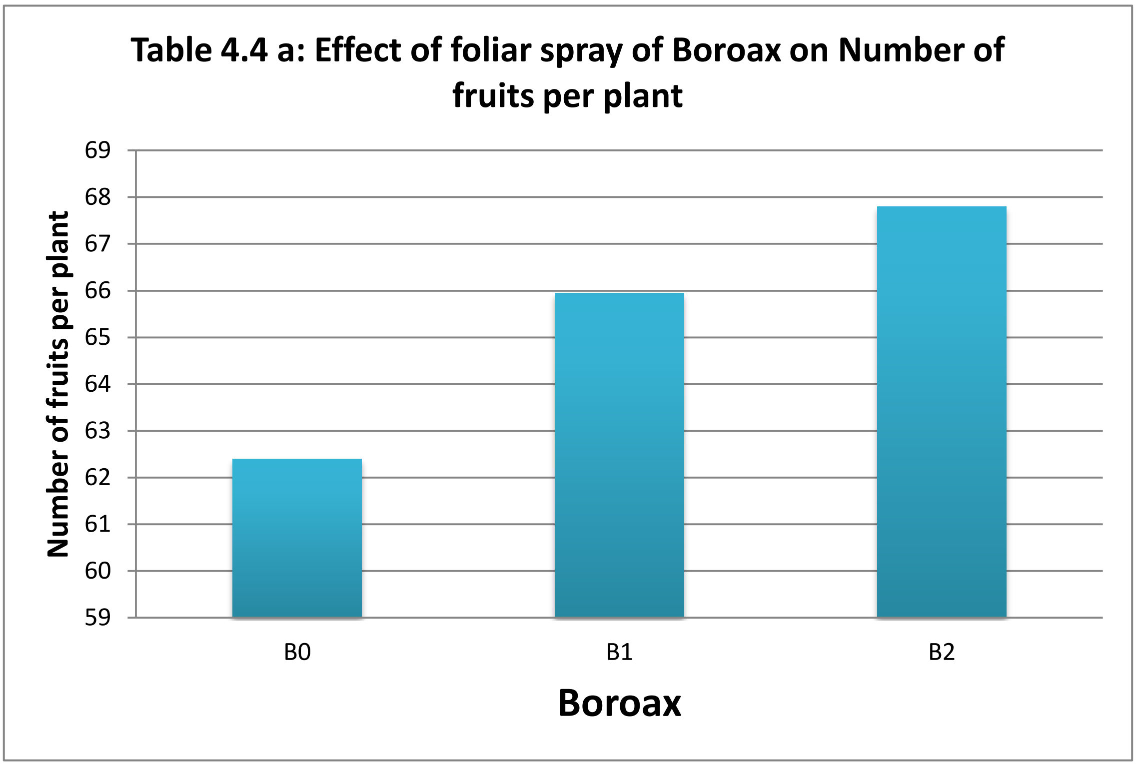
The interaction effects of Borax and Zinc sulphate were non-significantly increased the number of fruits per plant over the control. The maximum number of fruit (70) was recorded under treatment B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6 %) followed by B_1Z_2 (Borax @ 0.2% & ZnSo4 @ 0.6%) and B_2Z_1 (Borax @ 0.4% & ZnSo4 @ 0.6%), whereas the minimum number of fruits per plant (59.80) was recorded under the control (B_0 Z_0).

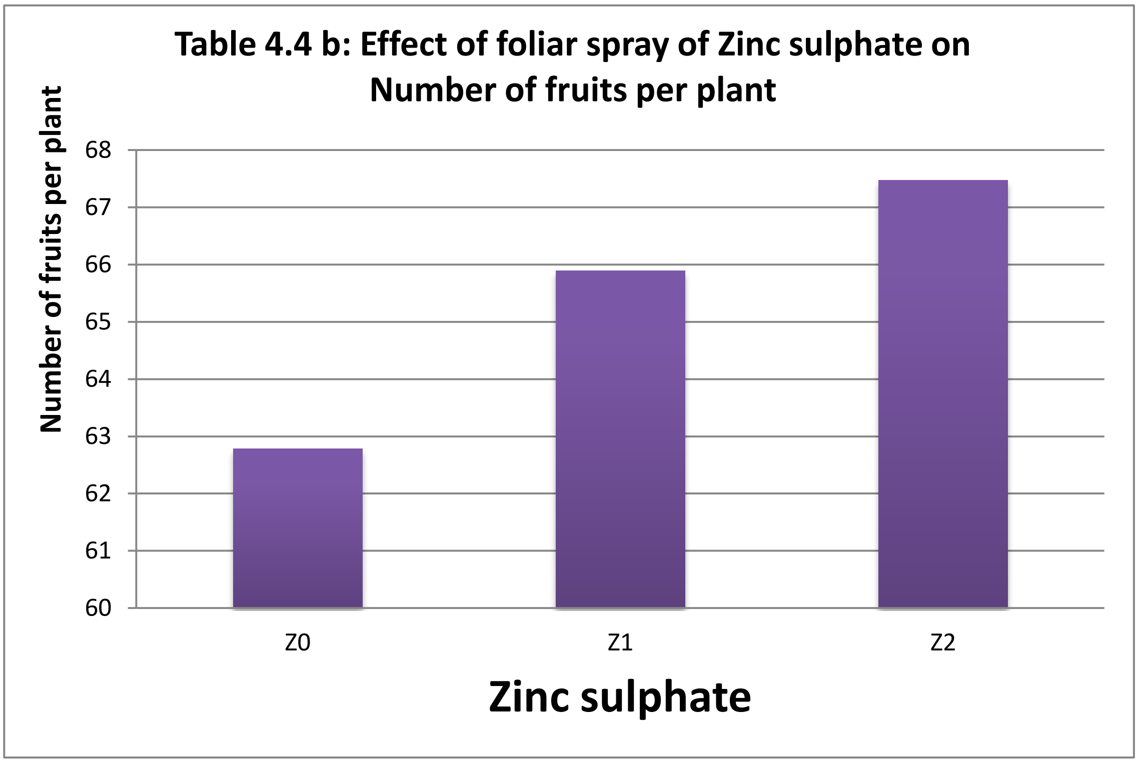
4.2.2 Average fruit weight (g)

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the fruit weight are presented in Table 4.5 and Figures 4.5a to 4.5b. The analysis of variance for same is given inappendix V.

4.2.2.1 Effect of Borax

The fruit weight was significantly increased with the spray of Borax over the control. The mean maximum fruit weight (142.28 g) was obtained under the treatment B_2 (Borax @ 0.4%). Significant differences were observed under B_2 and B_1 (Borax @ 0.2%), while the minimum fruit weight (134.11 g) was noted under control (B_0).





4.2.2.2 Effect of Zinc sulphate

The fruit weight was significantly increased with the spray of Zinc sulphate over the control. The maximum fruit weight (142.72 g) was obtained under the treatment Z_2 (ZnSo4 @ 0.6%) followed by Z_1(ZnSo4@ 0.4%),while the minimum fruit weight (132.28 g) was obtained under control (Z_0).

Table 4.5: Effect of foliar spray of Borax, Zinc sulphate and their interaction on weight of fruit (g)

Zinc sulphate	Borax			Mean
	B0	**B1**	**B2**	
Z_0	128.67	132.17	136.00	**132.28**
Z_1	134.67	135.17	143.00	**137.61**
Z_2	139.00	141.33	147.83	**142.72**
Mean	**134.11**	**136.22**	**142.28**	**137.54**

	Borax	Zinc sulphate	B X Z
S.Em.±	**1.880**	**1.880**	**3.255**
CD at 5% level	**5.635**	**5.635**	**NS**

4.2.2.3 Interaction effect of Borax and Zinc sulphate

The guava fruit weight was non-significantly influenced by the combined spray of Borax and Zinc sulphate over the control. The mean maximum fruit weight (147.83 g) was obtained under B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6 %) followed by B_1Z_2 (Borax @ 0.2% & ZnSo4 @ 0.6%), whereas the minimum fruit weight (128.67g) was found under control (B_0Z_0).

4.2.3 Fruit Yield per tree (kg)

The data relating to effect of Borax, Zinc sulphate and their interaction on the fruit yield per tree are presented in Table 4.7 and Figures 4.7a to 4.7b. The analysis of variance for same is given inappendix VII.

4.2.3.1 Effect of Borax

The fruit Yield per tree was significantly increased with the spray of Borax over the control. The mean maximum (46.08 kg) fruit yield per tree was obtained between B_2 (Borax @ 0.4%). Significant differences were observed under and B_1 (Borax @ 0.2%) respectively, while the minimum fruit yield per tree (40.77 kg) was recorded under control (B_0).

4.2.3.2 Effect of Zinc sulphate

The fruit Yield per treewas significantly increased with the spray of Zinc sulphate over the control. The maximum (46.25 kg) fruit Yield per treewas obtained under the treatment Z_2 (ZnSo4 @ 0.6%) followed by Z_1(ZnSo4@ 0.4%), while the minimum fruit Yield per tree(40.31kg) was obtained under control (Z_0).

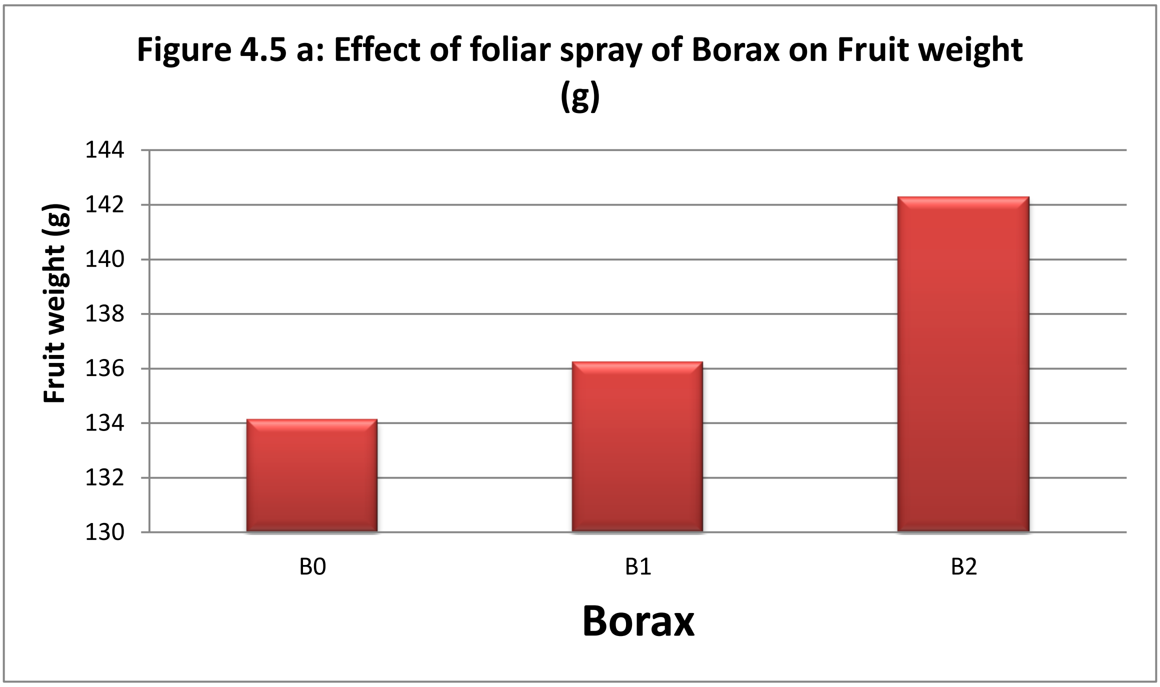


Figure 4.5 a: Effect of foliar spray of Borax on Fruit weight (g)
Fruit weight (g)
144
142
140
138
136
134
132
130
B0
B1
B2
Borax

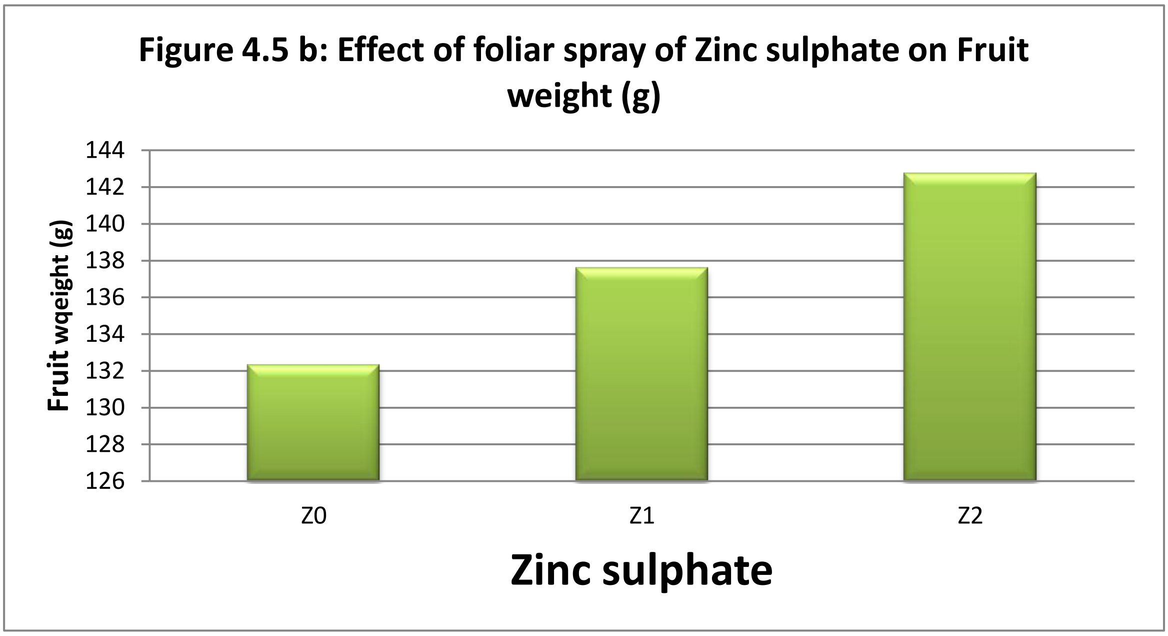


Figure 4.5 b: Effect of foliar spray of Zinc sulphate on Fruit weight (g)
Fruit wqeight (g)
144
142
140
138
136
134
132
130
128
126
Z0
Z1
Z2
Zinc sulphate

4.2.3.3 Interaction effect of Borax and Zinc sulphate

The combined spray of Borax and Zinc sulphate were non- significantly influenced the fruit Yield per tree over the control. The maximum fruit yield per tree (48.71 kg) was obtained under B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6 %) treatment which was significantly superior to the spray of other levels of treatment, whereas the minimum (37.92 kg), fruit yield per tree obtained under the control (B_0 Z_0).

Table 4.6: Effect of foliar spray of Borax, Zinc sulphate and their interaction on fruit yield per tree (kg)

Zinc Sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	37.92	39.68	43.34	**40.31**
Z_1	40.27	42.03	46.18	**42.83**
Z_2	44.13	45.90	48.71	**46.25**
Mean	**40.77**	**42.54**	**46.08**	**43.13**

	Borax	Zinc Sulphate	B X Z
S.Em.±	0.700	0.700	1.213
CD at 5% level	2.099	2.099	NS

4.2.4 Yield (q/ha)

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the yield per hectare are presented in Table 4.8 and Figures 4.8a to 4.8c. The analysis of variance for same is given in appendix VII.

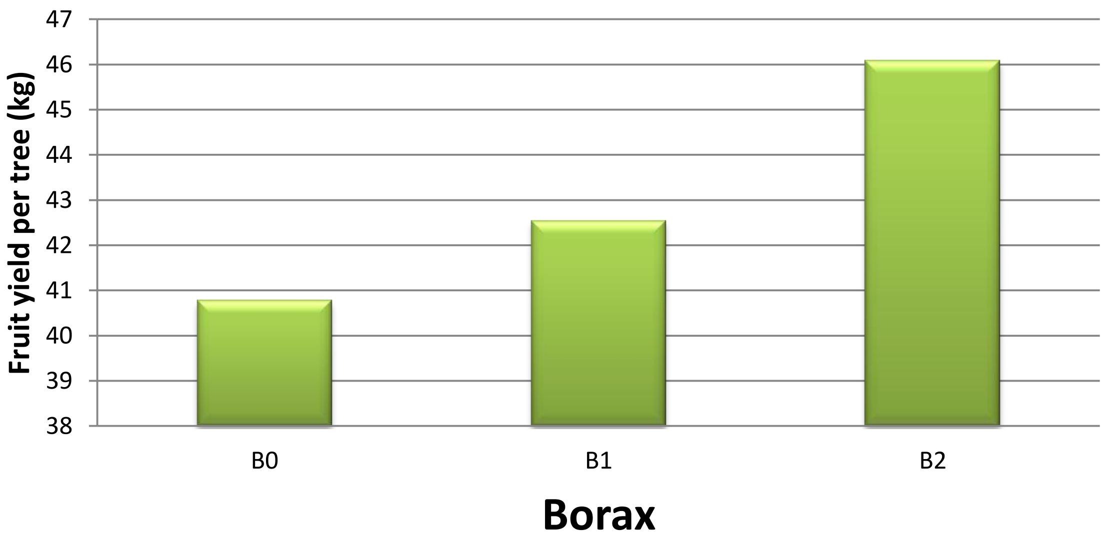
4.2.4.1 Effect of Borax

The fruit yield per hectare significantly increased with the spray of Borax over the control. The mean maximum (127.96 q) yield per hectare was obtained under the treatment B_2 (Borax @ 0.4%). Significant differences were observed between B_2 and B_1 (Borax @ 0.2%) respectively, while the minimum fruit yield per hectare (113.22 q) was recorded under control (B_0).

4.2.4.2 Effect of Zinc sulphate

The yield per plant significantly increased with the spray of Zinc sulphate over the control. The maximum (128.42 q) fruit yield per hectare was obtained under the treatment Z_2 (ZnSo4 @ 0.6%) followed by Z_1(ZnSo4 @ 0.4%), while the minimum fruit yield per hectare (111.95 q) was obtained under control (Z_0).

Figure 4.6 a: Effect of foliar spray of Borax on Fruit yield per tree (kg)



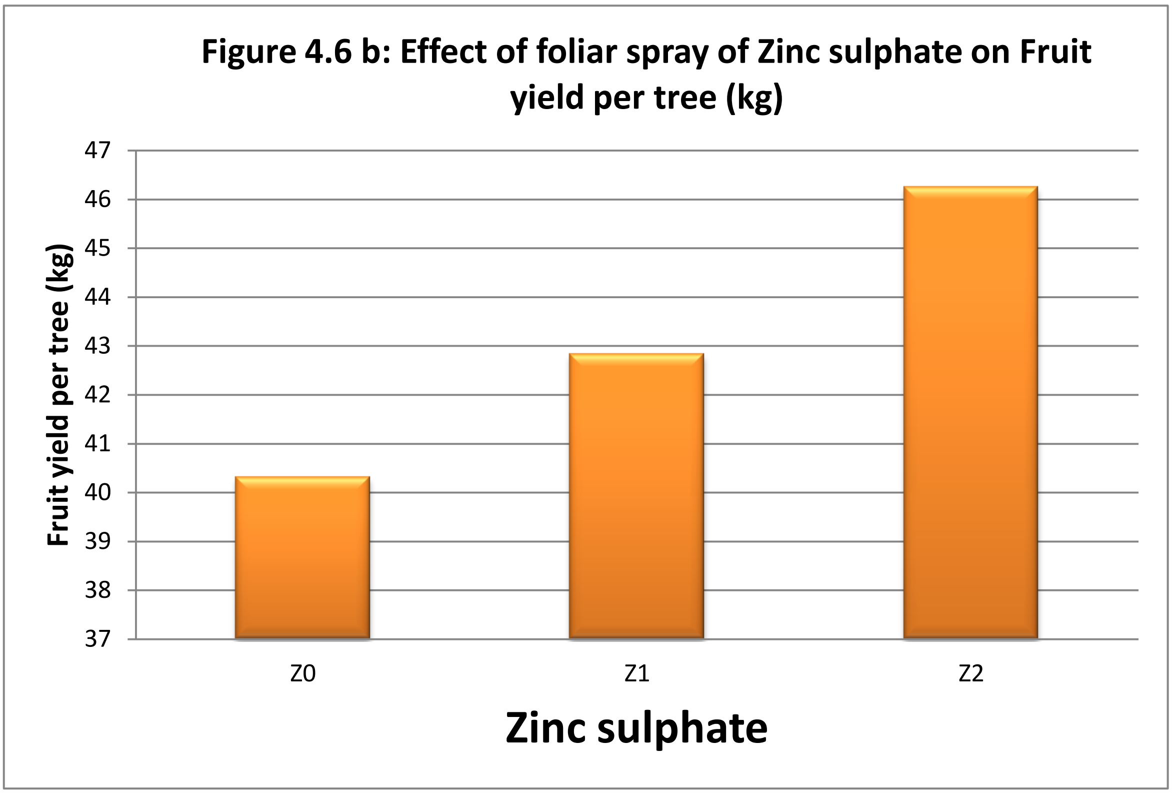


Table 4.7: Effect of foliar spray of Borax, Zinc sulphate and their interaction on fruit yield per hectare (q)

Zinc sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	105.31	110.20	120.35	111.95
Z_1	111.80	116.73	128.24	118.92
Z_2	122.53	127.43	135.29	128.42
Mean	113.22	118.12	127.96	119.76

	Borax	Zinc sulphate	B X Z
S.Em.±	1.944	1.944	3.367
CD at 5% level	5.828	5.828	NS

4.2.4.3 Interaction effect of Borax and Zincsulphate

The combined spray of Borax and Zinc sulphate did not influence the fruit yield per hectare over the control (Table 4.7 and fig. 4.7b). The maximum yield per hectare (135.29 q) was obtained under treatment B_2Z_2 (Borax @ 0.4% & Zinc sulphate @ 0.6 %) followed by B_1Z_2 (Borax @ 0.2% & Zinc sulphate @ 0.6%) while the minimum (105.31 q) fruit yield per hectare under the control (B_0Z_0).

4.2.5 Polar diameter

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the polar diameter are given in table 4.8 and fig 4.8a to 4.8b and analysis of variance for same is given in appendix VIII.

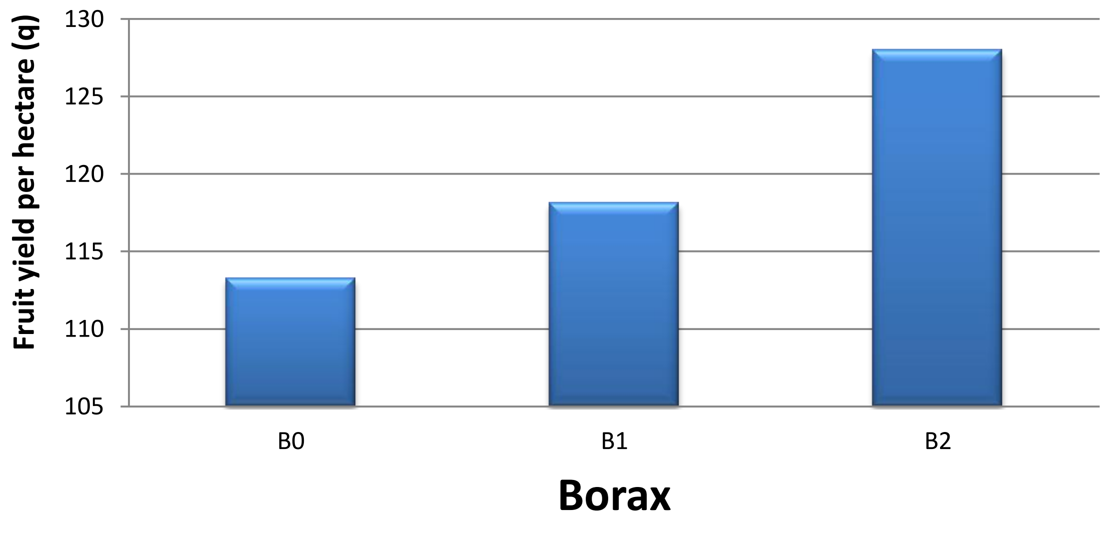
4.2.5.1 Effect of Borax

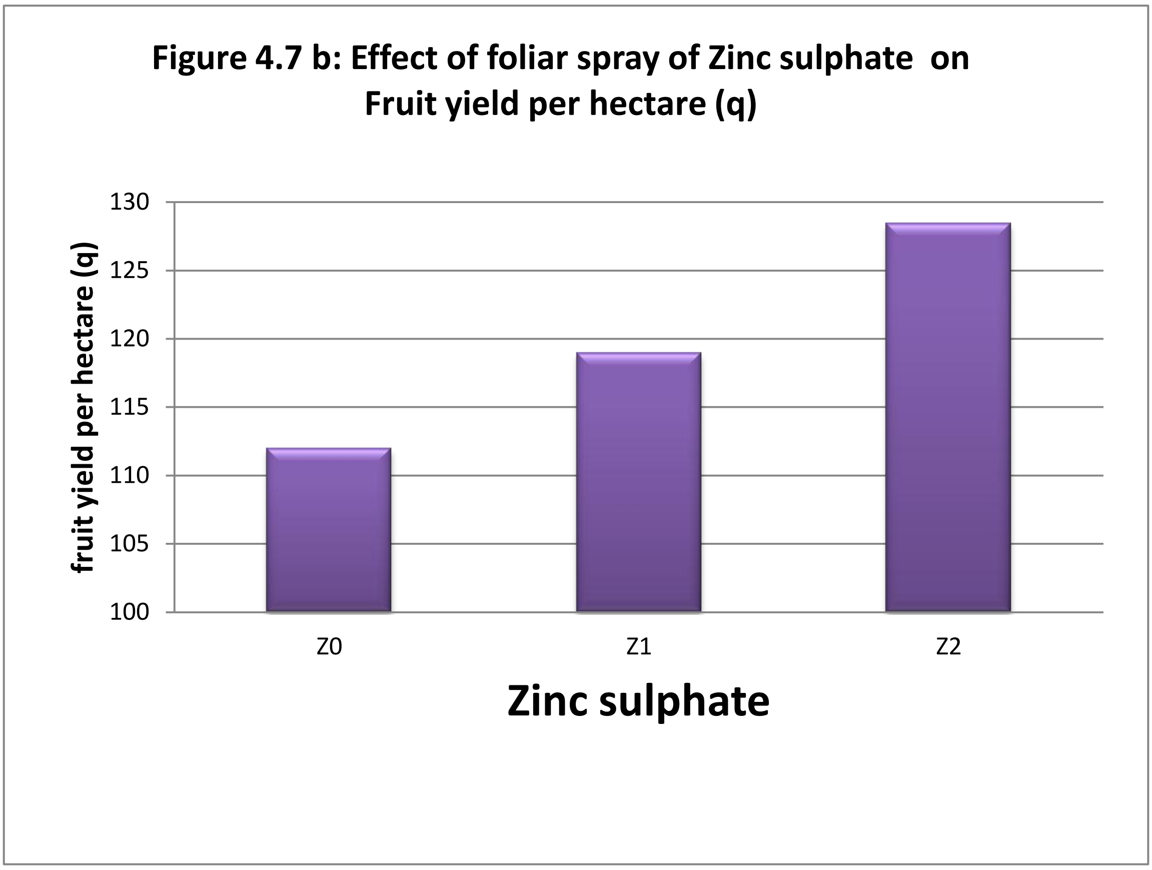
The polar diameter influenced significantly due to the foliar spray of Borax. The minimum polar diameter (6.06 cm) was recorded under B1 (Borax @ 0.2%), followed by other treatment, whereas the maximum polar diameter (7.03 cm) was recorded under the treatment B2 (Borax @ 0.4%).

4.2.5.2 Effect of Zinc sulphate

The polar diameter was found significant due to the foliar spray of Zinc sulphate. The maximum polar diameter (6.57cm) was recorded under the treatment Z_2($ZnSo4$@ 0.6%) , whereas the minimum polar diameter (6.21cm) was recorded under control (Z_0).

Figure 4.7 a: Effect of foliar spray of Borax on Fruit yield per hectare (q)





4.2.5.3 Interaction effect of Borax and Zinc sulphate

The interaction effects of Borax and Zinc sulphate were non-significantly increased polar diameter of fruit over the control. The maximum polar diameter (7.33 cm) was recorded under the treatment B_2Z_2(Borax @ 0.4% & ZnSo4@ 0.6%) followed by B_2Z_0(Borax @ 0.4% & control), whereas, the minimum polar diameter (5.51 cm) was recorded under the treatment B_1Z_o(Borax @ 0.2% & control) .

Table 4.8: Effect of foliar spray of Borax, Zinc sulphate and their interaction on polar diameter of fruit (cm).

Zinc sulphate	Borax			Mean
	B_0	**B_1**	**B_2**	
Z_0	5.80	5.51	7.31	**6.21**
Z_1	6.47	6.30	6.43	**6.40**
Z_2	6.01	6.36	7.33	**6.57**
Mean	**6.09**	**6.06**	**7.03**	**6.39**

	Borax	Zinc sulphate	B X Z
S.Em.±	0.118	0.118	0.204
CD at 5% level	0.352	0.352	NS

4.2.6 Radial diameter

The data pertaining to effect ofBorax, Zinc sulphate and their interaction on the radial diameter of fruit are given in table 4.9 and fig 4.9a to 4.9b and analysis of variance for same is given in appendix IX.

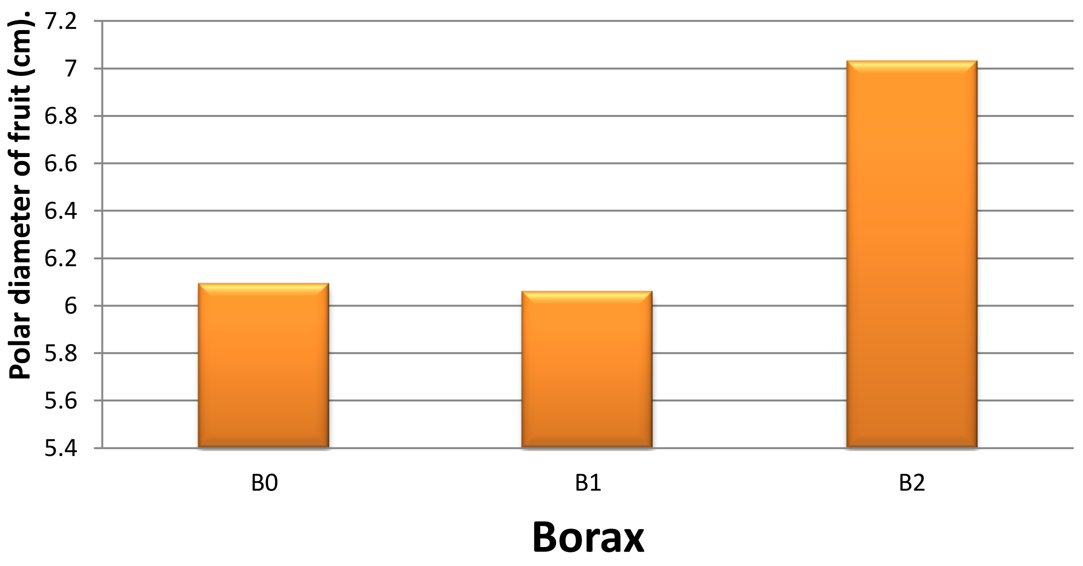
4.2.5.1 Effect of Borax

The radial diameter influenced significantly due to the foliar spray of Borax. The maximum radial diameter (6.49 cm) was recorded under the treatment B2 (Borax @ 0.4 %), followed by other treatment, whereas the minimum radial diameter (6.05cm) was recorded under the control(B0).

4.2.6.2 Effect of Zinc sulphate

The radial diameter was found significant due to the foliar spray of Zinc sulphate. The maximum radial diameter (6.5 cm) was recorded under the treatment Z_2(ZnSo4@ 0.6%) , whereas the minimum radial diameter (6.13cm) was recorded under control (Z_0).

Figure 4.8 a: Effect of foliar spray of Borax on Polar diameter of fruit (cm).



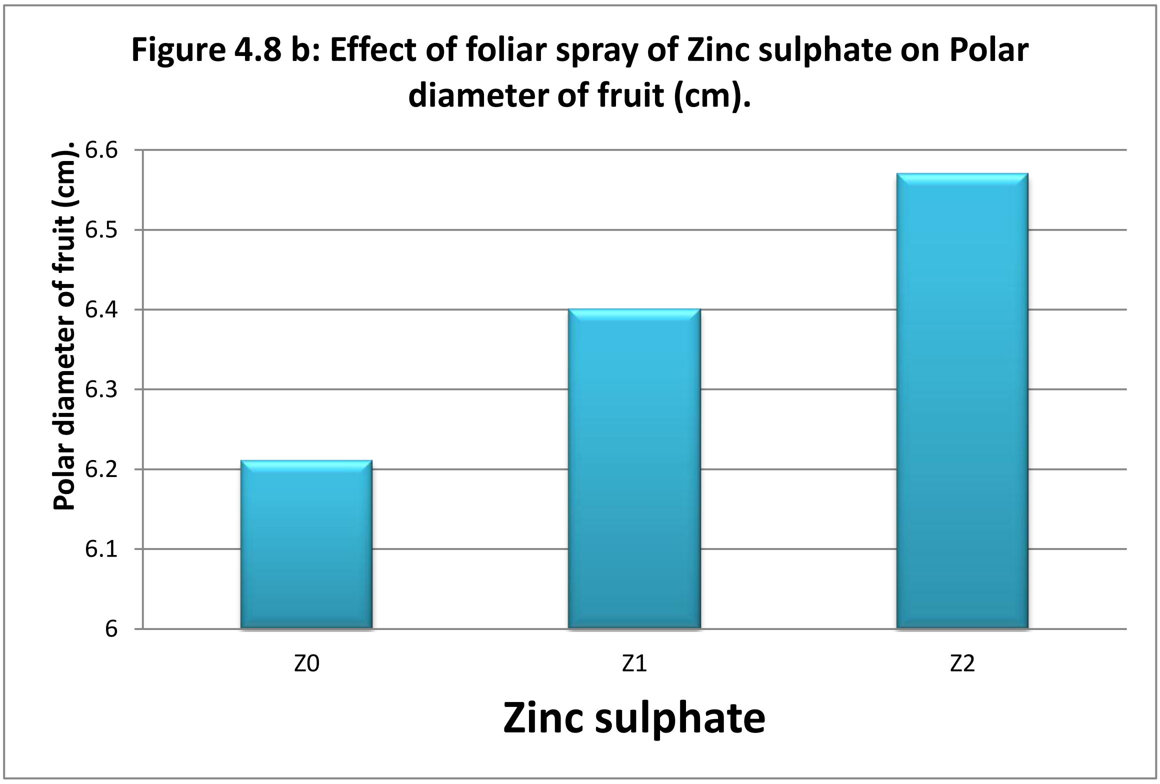


Table 4.9: Effect of foliar spray of Borax, Zinc sulphate and their interaction on radial diameter of fruit (cm).

Zinc Sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	5.68	6.21	6.51	**6.13**
Z_1	5.8	6.12	6.69	**6.2**
Z_2	6.69	6.83	6.27	**6.5**
Mean	**6.05**	**6.3**	**6.49**	**6.2**

	Borax	Zinc Sulphate	B X Z
S.Em.±	**0.130**	**0.190**	**0.208**
CD at 5% level	**0.400**	**0.560**	**Ns**

4.2.6.3 Interaction effect of Borax and Zinc Sulphate

The interaction effects of Borax and Zinc sulphate were non-significantly increased radial diameter of fruit over the control. The maximum radial diameter (6.83 cm) was recorded under the treatment B_1Z_2 (Borax @ 0.2% & ZnSo4@ 0.6%) followed by B_0Z_2 (control & ZnSo4 @ 0.6%), whereas, the minimum radial diameter (5.8 cm) was recorded under the treatment B_0 Z_1 (control & ZnSo4@ 0.4%) .

4.2.7 Pulp weight

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the pulp weight are presented in Table 4.10 and Figures 4.10a to 4.10b. The analysis of variance for same is given in appendix X.

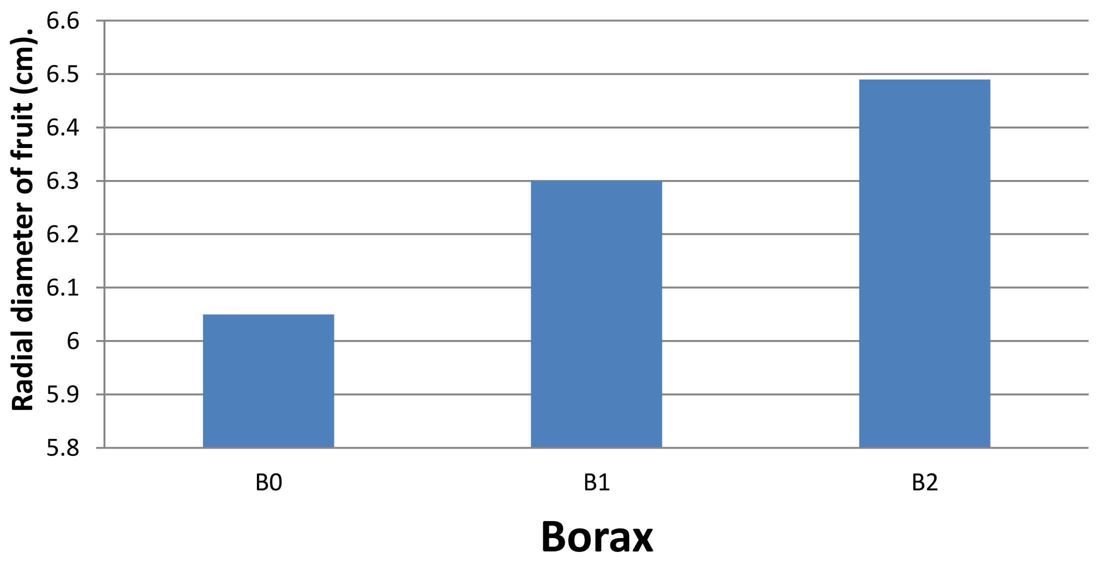
4.2.7.1 Effect of Borax

The pulp weight was significantly influenced by the foliar spray of Borax over the control. The maximum pulp weight (250 g) was recorded under the treatment B_2 (Borax @ 0.4%). Significant differences were observed under the control (B_0) respectively, while the minimum pulp weight (168 g) was recorded under the treatment B_1(Borax @ 0.2%).

4.2.7.2 Effect of Zinc sulphate

The pulp weight was significantly influenced by the foliar spray of Zinc sulphate over the control. The maximum pulp weight (217.44 g) was recorded under the treatment Z_1 (ZnSo4 @ 0.4%). Significant differences were observed under the treatment Z_2(ZnSo4 @ 0.6%)respectively, while the minimum pulp weight (174.87 g) was recorded under the control(Z_1)

Figure 4.9 a: Effect of foliar spray of Borax on Radial diameter of fruit (cm).



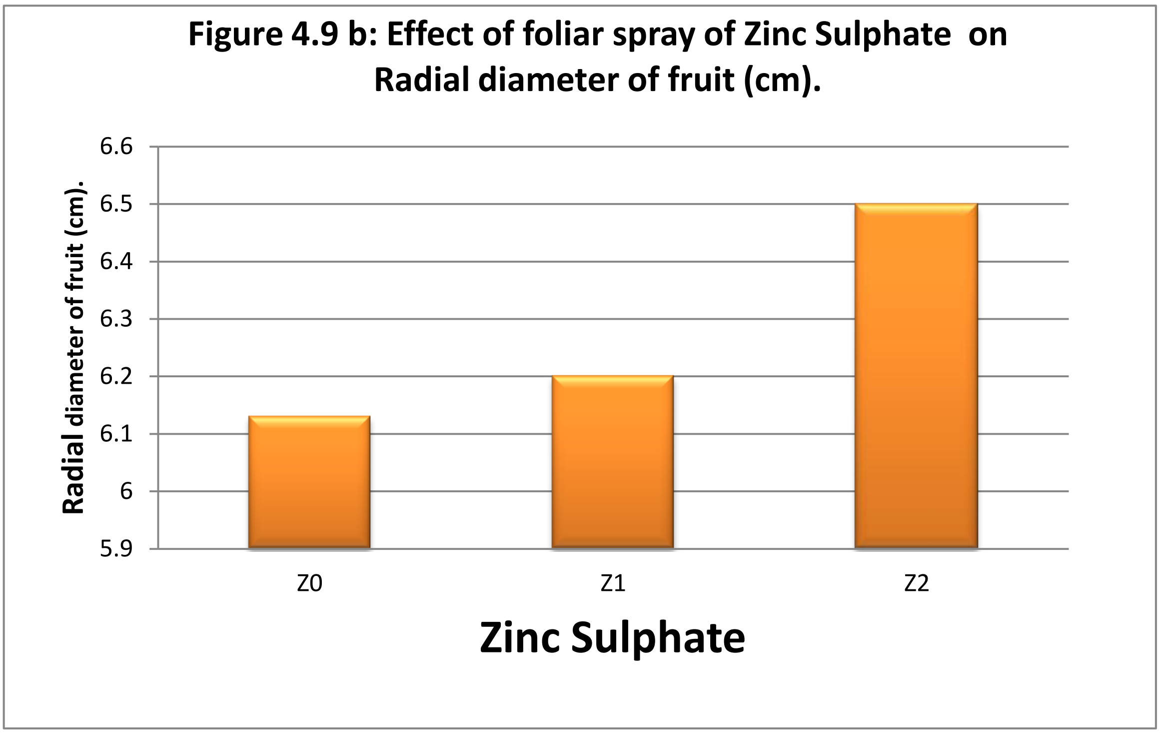


Table 4.10: Effect of foliar spray of Borax, Zinc sulphate and their interaction on pulp weight of fruit

Zinc sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	150.60	161.00	213.00	**174.87**
Z_1	183.33	172.00	297.00	**217.44**
Z_2	201.00	171.00	240.00	**204.00**
Mean	**178.31**	**168.00**	**250.00**	**198.77**

	Borax	Zinc sulphate	B X Z
S.Em.±	**0.333**	**0.333**	**0.577**
CD at 5% level	**0.999**	**0.999**	**NS**

4.2.7.3 Interaction effect of Borax and Zinc Sulphate

The interaction effects of Borax and Zinc sulphate were non-significantly increased pulp weight of fruit over the control. The maximum pulp weight (297.00 g) was recorded under the treatment B_2Z_1 (Borax @ 0.4% & ZnSo4@ 0.4%) followed by B_2Z_2(Borax @ 0.4% & ZnSo4@ 0.6%) , whereas, the minimum (150 g) was recorded under the control (B_0 Z_0).

4.2.8 seed weight

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the seed weight are presented in Table 4.11 and Figures 4.11a to 4.11b. The analysis of variance for same is given in appendix XI.

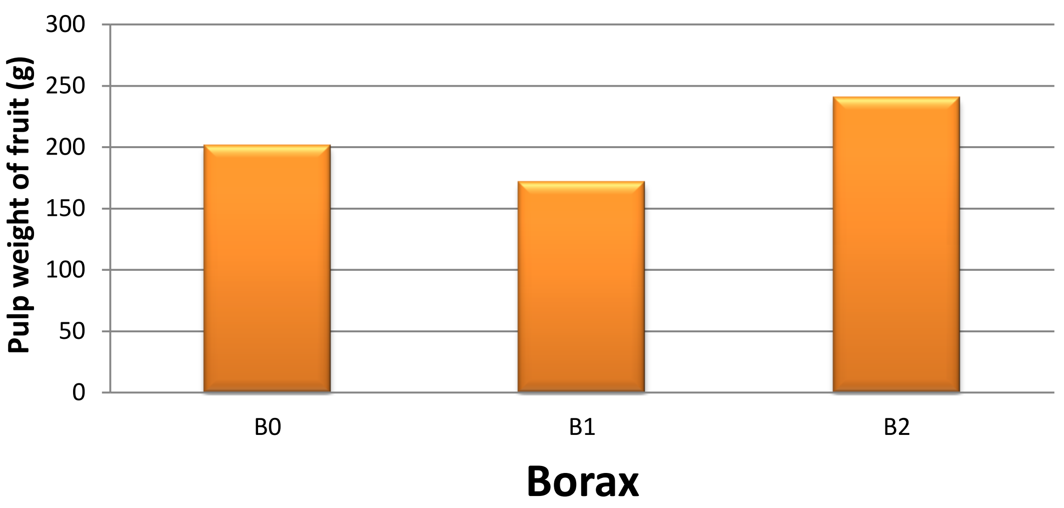
4.2.8.1 Effect of Borax

The seed weight was significantly influenced by the foliar spray of Borax over the control. The maximum seed weight (250 g) was recorded under the treatment B2 (Borax @ 0.4%). Significant differences were observed under the control (B_0) respectively, while the minimum seed weight (168 g) was recorded under the treatment B_1(Borax @ 0.2%).

4.2.8.2 Effect of Zinc sulphate

The seed weight was significantly influenced by the foliar spray of Zinc sulphate over the control. The maximum seed weight (2.56 g) was recorded under the control (Z_0). Significant differences were observed under the treatment Z_1(ZnSo4 @ 0.4%)respectively, while the minimum seed weight (1.78 g) was recorded under the treatment Z2 (ZnSo4 @ 0.6%).

Figure 4.10 a: Effect of foliar spray of Borax on pulp weight of fruit(g)



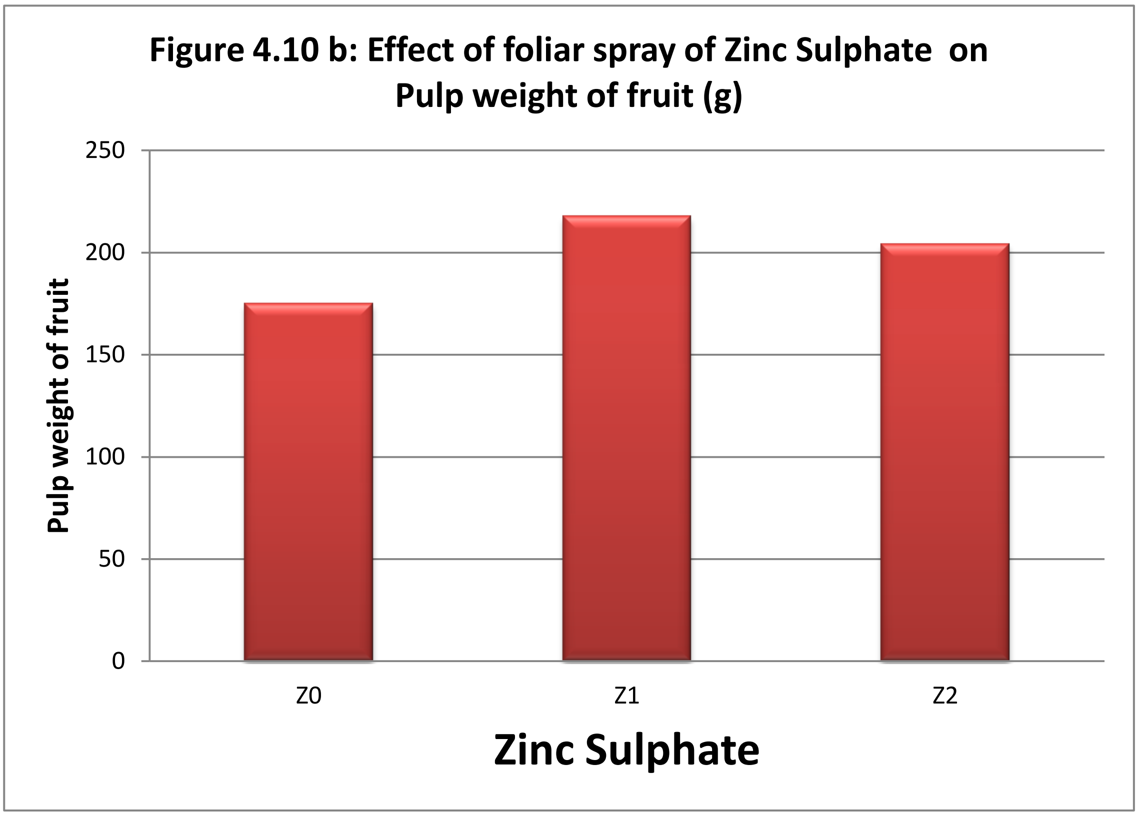


Table 4.11: Effect of foliar spray of Borax, Zinc sulphate and their interaction on seed weight of fruit

Zinc sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	3.63	2.26	1.78	**2.56**
Z_1	1.95	2.01	1.75	**1.90**
Z_2	1.73	1.92	1.69	**1.78**
Mean	**2.44**	**2.06**	**1.74**	**2.08**

	Borax	Zinc sulphate	B X Z
S.Em.±	0.060	0.060	0.104
CD at 5% level	0.180	0.180	NS

4.2.8.3 Interaction effect of Borax and Zinc Sulphate

The interaction effects of Borax and Zinc sulphate non-significantly increased seed weight of fruit over the control. The minimum seed weight (1.69 g) was recorded under the treatment B_2Z_2(Borax @ 0.4% & ZnSo4@ 0.6%) whereas, the maximum (3.63 g) was recorded under the control (B_0 Z_0).

4.3 Bio-Chemical parameters

The data pertaining to various bio- chemical parameters of the guava plant viz. TSS (^{0}Brix) and acidity (%) are given in Tables 4.12 to 4.13 and Figures 4.12a to 4.13b. The analysis of variance for the same is given in appendices XII to XIII.

4.3.1 Acidity (%)

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the acidity percentage are given in table 4.12 and fig 4.12a to 4.12b and analysis of variance for same is given in appendix XII.

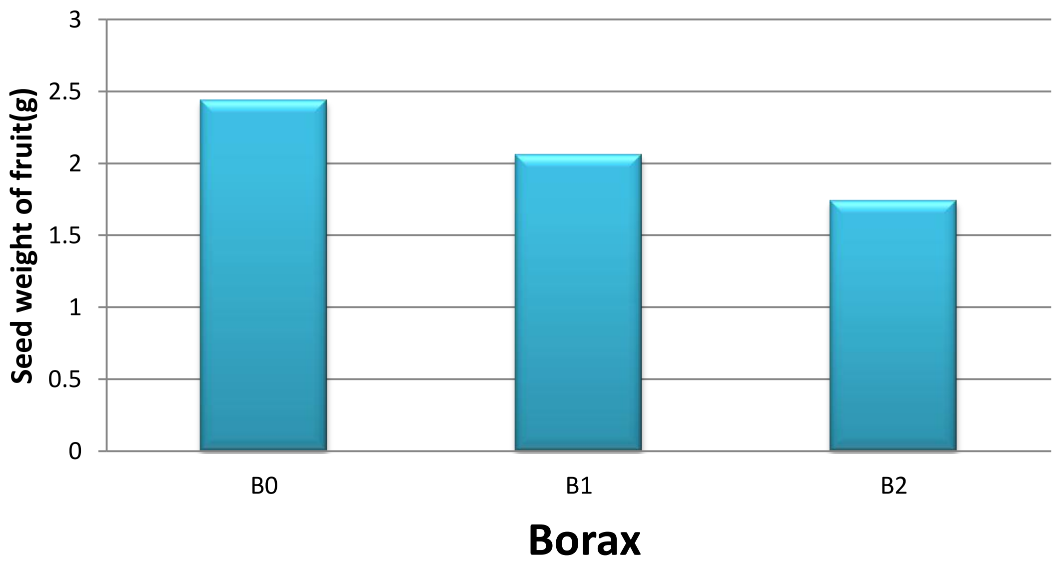
4.3.1.1 Effect of Borax

The acidity of fruit was influenced significantly due to the foliar spray of Borax. The minimum acidity (0.22 %) was recorded under B2 (Borax @ 0.4%), followed by B1(Borax @ 0.2%), whereas the maximum acidity (0.30 %) was recorded under control (B_0).

4.3.1.2 Effect of Zinc sulphate

The acidity percentage was found significant due to the foliar spray of Zinc sulphate . The minimum acidity (0.24%) was recorded under the treatment Z_2 (ZnSo4@ 0.6%) , whereas the maximum acidity (0.31 %) was recorded under control (Z_0).

Figure 4.11 a: Effect of foliar spray of Borax on Seed weight of fruit (g)



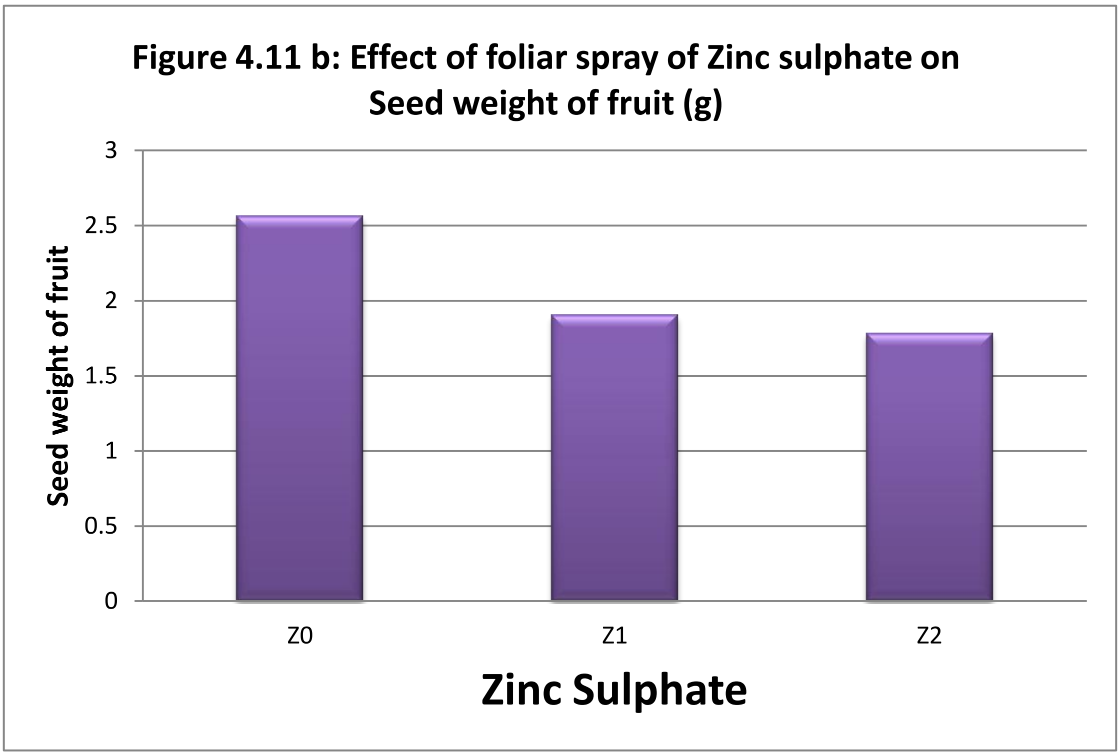


Table 4.12: Effect of foliar spray of Borax, Zinc sulphate and their interaction on acidity (%)

Zinc sulphate	Borax			Mean
	B_0	**B_1**	**B_2**	
Z_0	0.37	0.31	0.25	**0.31**
Z_1	0.29	0.25	0.22	**0.25**
Z_2	0.23	0.29	0.20	**0.24**
Mean	**0.30**	**0.28**	**0.22**	**0.27**

	Borax	Zinc sulphate	B X Z
S.Em.±	**0.006**	**0.006**	**0.010**
CD at 5% level	**0.018**	**0.018**	**NS**

4.3.1.3 Interaction effect of Borax and Zinc sulphate

The interaction effects of Borax and Zinc sulphate non-significantly reduced the acidity (%) of fruit over the control. The minimum acidity (0.20 %) was recorded under the treatment B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6 %) followed by

B_2Z_1 (Borax @ 0.4% & ZnSo4 @ 0.4%), whereas, the maximum (0.37 %) was recorded under the treatment control (B_0 Z_0).

4.3.2 TSS (^{0}Brix)

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the TSS is given in table 4.13 and fig 4.13a to 4.13b and analysis of variance for same is given in appendix XIII.

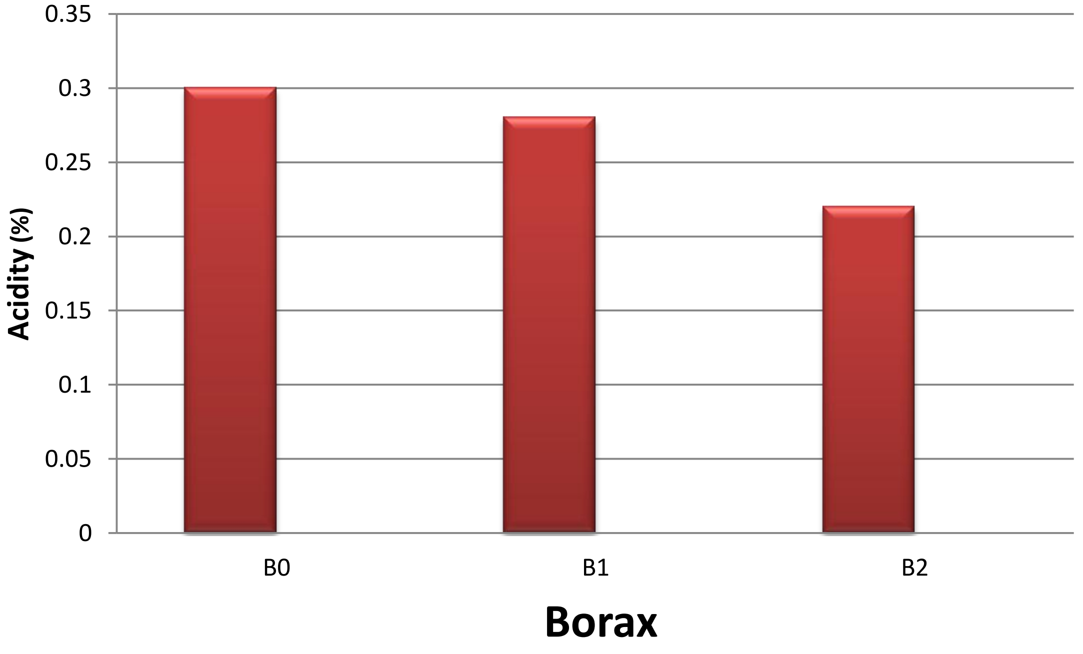
4.3.2.1 Effect of Borax

The TSS was found to be significantly influenced due to the foliar spray of Borax. The maximum TSS (13.4^{0}Brix) was recorded under treatment B_2 (Borax @ 0.4%) followed by B_1(Borax @ 0.2%) whereas, minimum TSS (8.54^{0}Brix) under control (B_0).

4.3.2.2 Effect of Zinc sulphate

The TSS was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum TSS (11.89 ^{0}Brix) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum TSS (10.44 ^{0}Brix), was recorded under the control (Z_0).

Figure 4.12 a: Effect of foliar spray of Borax on Acidity (%)



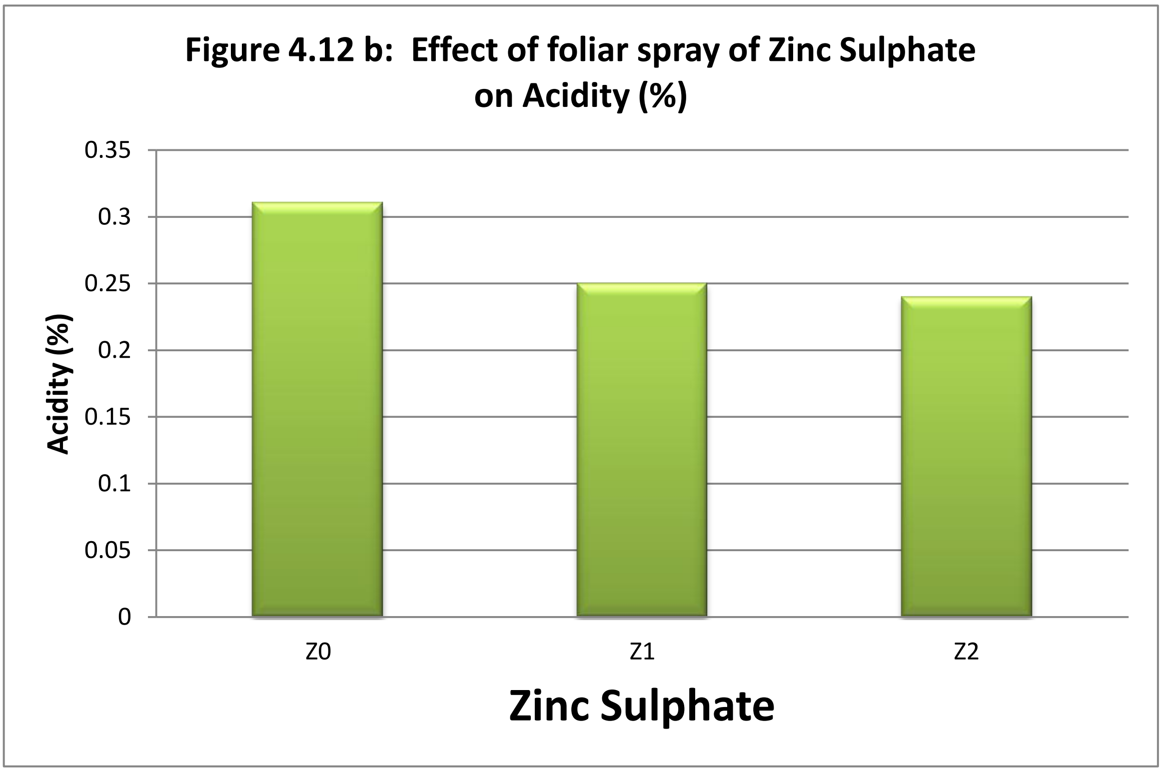


Table 4.13: Effect of foliar spray of Borax, Zinc sulphate and their interaction on TSS (^{0}Brix)

Zinc sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	7.3	10.78	13.2	**10.44**
Z_1	8.59	11.80	13.5	**11.30**
Z_2	9.68	12.30	13.7	**11.89**
Mean	**8.54**	**11.63**	**13.4**	**11.21**

	Borax	Zinc sulphate	B X Z
S.Em.±	**0.038**	**0.038**	**0.066**
CD at 5% level	**0.113**	**0.113**	**NS**

4.3.2.3 Interaction effect of Borax and Zinc sulphate

The interaction effect of Borax and Zinc sulphate on TSS was found to be non significant. The maximum TSS (13.7 ^{0}Brix) was recorded under treatment B_2Z_2 (Borax @ 0.4 % & Zinc sulphate @ 0.6 %) followed by B_2Z_1 (Borax @ 0.4% & ZnSo4@ 0.4%), whereas the minimum TSS (7.30^{0}Brix) was recorded under the control (B_0Z_0).

4.4 Organoleptic parameters

The data pertaining to various organoleptic parameters of the guava fruit viz. taste, colour, appearance, aroma and over allacceptibility are given in Tables 4.14 to 420. The analysis of variance for the same is given in appendices XIX to XXII.

4.4.1 Taste

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the taste is given in table 4.14 and analysis of variance for same is given in appendix XIV.

4.4.1.1 Effect of Borax

The taste was found to be significantly influenced due to the foliar spray of Borax. The maximum taste score (7.20) was recorded under treatment B_2 (Borax @ 0.4%) followed by B_1(Borax @ 0.2%) whereas, minimum taste score (6.66) was noted under control (B_0).

4.4.1.2 Effect of Zinc sulphate

The taste was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum taste (7.03) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum taste (6.91), was recorded under the control (Z_0).

Figure 4.13 a: Effect of foliar spray of Borax on TSS (0Brix)

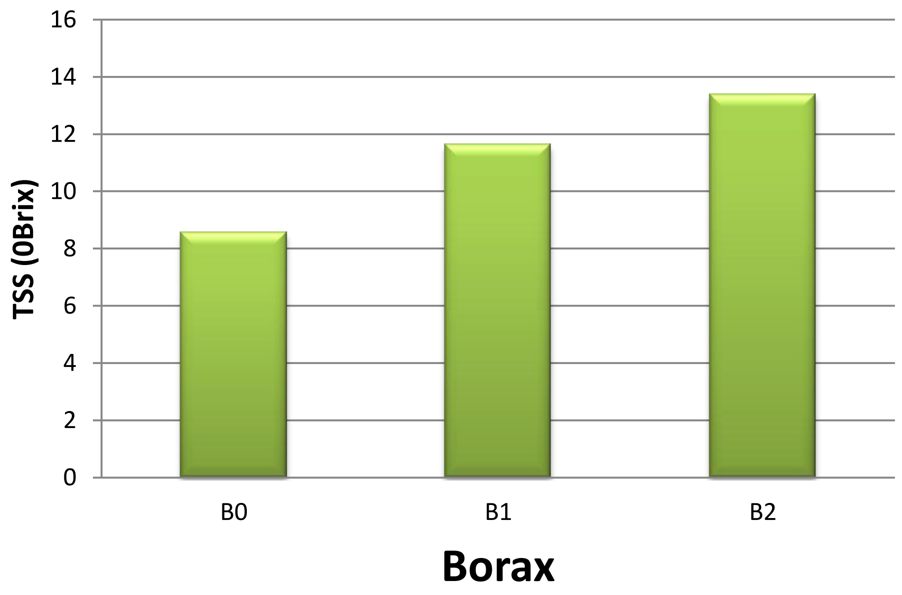


Figure 4.13 b: Effect of foliar spray of Zinc Sulphate on TSS (0Brix)

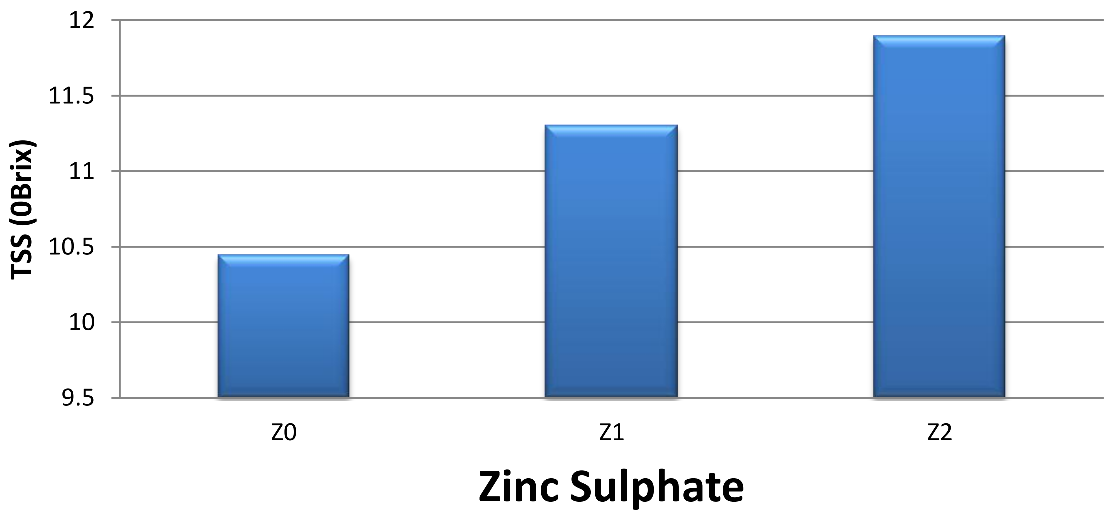


Table 4.14: Effect of foliar spray of Borax, Zinc sulphate and their interaction on taste

Zinc sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	6.50	7.13	7.10	**6.91**
Z_1	6.70	7.10	7.20	**7.00**
Z_2	6.77	7.03	7.30	**7.03**
Mean	**6.66**	**7.09**	**7.20**	**6.98**

	Borax	Zinc sulphate	B X Z
S.Em.±	0.032	0.032	0.055
CD at 5% level	0.095	0.095	NS

4.4.1.3 Interaction effect of Borax and Zinc sulphate

The interaction effect of Borax and Zinc sulphate on taste was found to be non significant. The maximum taste score (7.30) was recorded under treatment B_2Z_2 (Borax @ 0.4 % & Zinc sulphate @ 0.6 %) followed by B_2Z_1 (Borax @ 0.4% & ZnSo4@ 0.4%), whereas the minimum taste score (6.50) was recorded under the control (B_0Z_0).

4.4.2 colour and appearance

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the colour and appearance is given in table 4.15 and analysis of variance for same is given in appendix XV.

4.4.2.1 Effect of Borax

The colour and appearance was found to be non significantly influenced due to the foliar spray of Borax. The mean maximum colour and appearance score (6.33) was recorded under treatment B_2 (Borax @ 0.4%) followed by B1(Borax @ 0.2%) whereas, minimum colour and appearance score (6.07) under control (B_0).

4.4.1.2 Effect of Zinc sulphate

The color and appearance was found to be non significant due to the foliar spray of Zinc sulphate over the control. The mean maximum colour and appearance (6.23) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum colour and appearance (6.17), was recorded under the control (Z_0).

Table 4.15: Effect of foliar spray of Borax, Zinc sulphate and their interaction on colour and appearance

Zinc sulphate	Borax			Mean
	B_0	B_1	B_2	
Z_0	6.03	6.13	6.33	**6.17**
Z_1	6.03	6.27	6.33	**6.21**
Z_2	6.13	6.23	6.33	**6.23**
Mean	**6.07**	**6.21**	**6.33**	**6.20**

	Borax	Zinc sulphate	B X Z
S.Em.±	0.012	0.012	0.021
CD at 5% level	NS	NS	NS

4.4.1.3 Interaction effect of Borax and Zinc sulphate on colour and appearance

The interaction effect of Borax and Zinc sulphate on colour and appearance was found to be non significant. The maximum colour and appearance score (6.33) was recorded under treatment B_2Z_0(Borax @ 0.4 % & Zinc sulphate 0%),B_2Z_1(Borax @ 0.4 % & Zinc sulphate @ 0.4 %)B_2Z_2(Borax @ 0.4 % & Zinc sulphate 0.6%) , followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%), whereas the minimum colour and appearance score (6.03) was recorded under the control (B_0Z_0) andB_0Z_1(Borax @ 0% & Zinc sulphate 0.4%).

4.4.3 Aroma

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the aroma is given in table 4.16 and analysis of variance for same is given in appendix XVI.

4.4.3.1 Effect of Borax

The aroma was found to be significantly influenced due to the foliar spray of Borax. The mean maximum aroma score (6.40) was recorded under treatment B_2 (Borax @ 0.4%) followed by B_1(Borax @ 0.2%) whereas, minimum aroma score (6.04) under control (B_0).

4.4.3.2 Effect of Zinc sulphate

The aroma was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum aroma (6.28) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum aroma (6.14), was recorded under the control (Z_0).

Table 4.16: Effect of foliar spray of Borax, Zinc sulphate and their interaction on aroma

Zinc sulphate	**Borax**			**Mean**
	B_0	**B_1**	**B_2**	
Z_0	6.03	6.10	6.30	**6.14**
Z_1	6.07	6.20	6.40	**6.22**
Z_2	6.03	6.30	6.50	**6.28**
Mean	6.04	6.20	6.40	**6.21**

	Borax	**Zinc sulphate**	**B X Z**
S.Em.±	**0.018**	**0.018**	**0.031**
CD at 5% level	**0.054**	**0.054**	**0.093**

4.4.3.3 Interaction effect of Borax and Zinc sulphate

The interaction effect of Borax and Zinc sulphate on aroma was found to be significant. The mean maximum aroma score (6.50) was recorded under treatment B_2Z_2(Borax @ 0.4 % & Zinc sulphate 0.6%), followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%) , whereas the mean minimum aroma score (6.03) was recorded under the control (B_0Z_0) andB_0Z_2(Borax @ 0% & Zinc sulphate 0.6%).

4.4.4 Over all acceptability

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the over allacceptibility is given in table 4.17 and analysis of variance for same is given in appendix XVII.

4.4.4.1 Effect of Borax

The over allacceptibility was found to be significantly influenced due to the foliar spray of Borax. The mean maximum over all acceptibility score (6.53) was recorded under treatment B_2 (Borax @ 0.4%) followed by B_1(Borax @ 0.2%) whereas, minimum over all acceptibility score (6.22) under control (B_0).

4.4.4.2 Effect of Zinc sulphate

The over allacceptibility was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum over all acceptability score (6.44) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum over all acceptability score (6.22), was recorded under the control (Z_0).

Table 4.17: Effect of foliar spray of Borax, Zinc sulphate and their interaction on over all acceptability

Zinc sulphate	Borax			Mean
	B_0	**B_1**	**B_2**	
Z_0	6.13	6.37	6.40	**6.30**
Z_1	6.23	6.57	6.50	**6.43**
Z_2	6.30	6.33	6.70	**6.44**
Mean	**6.22**	**6.42**	**6.53**	**6.39**

	Borax	Zinc sulphate	B X Z
S.Em.±	**0.056**	**0.056**	**0.098**

CD at 5% level	**0.169**	**0.169**	**NS**

4.4.4.3 Interaction effect of Borax and Zinc sulphate

The interaction effect of Borax and Zinc sulphate on over all acceptibility was found to be nonsignificant. The mean maximum over all acceptibility score (6.70) was recorded under treatment B_2Z_2(Borax @ 0.4 % & Zinc sulphate 0.6%), followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%) , whereas the mean minimum over all acceptibility score (6.13) was recorded under the control (B_0Z_0).

4.5 Post harvest parameters

4.5.1 Physiological loss in weight (PLW) (%)

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the PLW percentage are given in table 4.18.

The PLW% is presented in Table 4.18 and The minimum physiological loss in weight was recorded 4.90 per cent at 4 days with foliar application of Zinc sulphate @ 0.6 (T_5). The maximum physiological loss in weight was recorded 7.10 per cent at 4 days under control (T_1).

Table 4.18: Effect of foliar application of Borax and Zinc sulphate on Physiological loss in weight .

Treatment	**Physiological loss in weight (%)**
T_1–control	7.10
T_2 -Borax (0.2%)	5.70
T_3 -Borax(0.4%)	5.30
T_4 -Zinc sulphate (0.4%)	5.10
T_5 -Zinc sulphate(0.6%)	4.90
T_6 -(Borax @0.2%+ZnSo4@0.4%)	6.00
T_7-(Borax @0.2%+ZnSo4@0.6%)	5.80
T_8 -(Borax @0.4%+ZnSo4@0.4%)	5.60
T_9-(Borax @0.4%+ZnSo4@0.6%)	5.50
SEm±	**0.077**
CD at 5%	**0.239**

4.5.2 Fruit spoilage %

The data pertaining to effect of spray of Borax, Zinc sulphate and their interaction on the fruit spoilage percentage are given in table 4.19 .

The minimum spoilage % were observed (3.68 %) and (3.23 %) on the 5th day of storage, (11.43 %) and (11.12 %) on the 10th day of storage, (20.96 %) and (20.56 %) on the 15th day storage were observed with treatments B_2(Borax @ 0.4 %) and Z_2 (zinc sulphate @ 0.6 %) respectively. however maximum decay per cent was recorded in the control.The minimum spoilage %(4.11 %), (11.11%)and (20.77%) was recorded with treatment B_2Z_2 (Borax @ 0.4 % + ZnSo4@ 0.6 %) at 5th, 10th and 15th day of storage respectively, However, the maximum spoilage % (7.72 %), (16.89 %) and (28.44 %) was recorded under control at 5th, 10th and 15th day of storage, respectively.

Table 4.19: Effect of foliar application of Borax and Zinc sulphate on fruit spoilage % .

Treatments	**Decay (%)**		
	At 5th day	**At 10th day**	**At 15th day**
Borax			
B_0	5.74	14.65	24.64
B_1	4.92	12.37	22.46
B_2	3.68	11.43	20.96
S.Em$\pm$	0.360	0.540	0.435
CD at 5%	1.04	1.52	1.23
$ZnSO_4$			
Z_0	5.77	14.78	23.47
Z_1	4.52	13.34	22.14
Z_2	3.23	11.12	20.56
S.Em$\pm$	0.360	0.540	0.435
CD at 5%	1.04	1.52	1.23
B_0 Z_0	7.72	16.89	28.44
B_1 Z_1	5.33	12.68	24.34
B_1 Z_2	5.50	12.34	22.23
B_2 Z_1	4.44	13.23	22.33

B_2 Z_2	4.11	11.11	20.77
S.Em±	0.17	0.24	0.45
CD at 5%	0.55	0.62	1.25

4.5.3 Shelf life (days)

The data pertaining to effect of Borax, Zinc sulphate and their interaction on the shelf life of fruit (days) are given in table 4.20.The helf life of fruit is presented in Table 4.20. The maximum shelf life of fruit recorded 5.2 days with foliar spray of Zinc sulphate @ 0.6% (T_5) significantly superior to other treatments followed by T_3 and T_7. The minimum fruit storage stability is recorded 2.00 days under control (T_1).

Table 4.20: Effect of foliar application of Borax and Zinc sulphate on shelf life of fruit

Treatment	**Shelf life of fruit**
T_1–control	2.00
T_2 -Borax (0.2%)	3.20
T_3 -Borax(0.4%)	4.00
T_4 -Zinc sulphate (0.4%)	3.50
T_5 -Zinc sulphate(0.6%)	5.20
T_6 -(Borax @0.2%+ZnSo4@0.4%)	3.00
T_7-(Borax @0.2%+ZnSo4@0.6%)	3.60
T_8 -(Borax @0.4%+ZnSo4@0.4%)	3.40
T_9-(Borax @0.4%+ZnSo4@0.6%)	3.30
SEm±	**0.120**
CD at 5%	**0.371**

Economic analysis

A critical examination of data presented in the preceeding chapter revealed that various treatments of Borax and Zinc sulphate increased the net return and B:C ratio. Maximum net returns (Rs 2, 43,280/ ha) was recorded in B_2Z_2 (Borax @ 0.4% & ZnSo4@ 0.6 %) and the minimum (Rs 192674/ ha) in control. Whereas, minimum B: C ratio(1:8.00) was recorded with B_0Z_0(no Borax @ & no ZnSo4), while maximum (1:9.97) was in B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6 %). The net income and B:C ratio was calculated taking sale price of fruits @ 20/kg.

Table 4.21 Economics of the different treatments (per ha.)

Treatments		Common expenditure / (ha)	Treat. Cost (Rs)	Total Expenditure / ha	Gross Income / ha	Net Income / ha	B:C Ratio
T_2	B_0Z_0	25000	0	25000.00	220200.00	192674.00	1:8.00
T_2	B_0Z_1	25000	1500	26500.00	223600.00	197100.00	1:8.44
T_3	B_0Z_2	25000	2155	27155.00	245000.00	217845.00	1:9.02
T_4	B_1Z_0	25000	2526	25726.00	210600.00	185600.00	1:8.42
T_5	B_1Z_1	25000	3830	28830.00	233400.00	204570.00	1:8.10
T_6	B_1Z_2	25000	5621	30621.00	254800.00	224179.00	1:8.32
T_7	B_2Z_0	25000	5100	30001.00	240600.00	210599.00	1:8.02
T_8	B_2Z_1	25000	5801	28600.00	256400.00	227800.00	1:8.97
T_9	B_2Z_2	25000	5675	27120.00	270400.00	243280.00	1:9.97

Chapter – V
DISCUSSION

An investigation entitled, “Effect of foliar application of Borax and Zinc sulphate on growth, yield and quality of Guava *(PsidiumguajavaL.)* cv. Gwalior-27” was carried out at the Agrotechnology Park of KrishiVigyan Kendra, College of Agriculture, Gwalior during the year 2016-17.

The results obtained during the course of investigation have been discussed below in this chapter under appropriate headings and sub headings.

(A) Effect of Borax

(a) Growth Parameters

The growth parameters of the guava plant were significantly influenced by the different concentration of Borax over the control. The mean maximum tertiary shoot length (6.43 cm) was recorded under B_2(Borax @ 0.4%) which was superior with other treatments whereas, the mean minimum tertiary shoot length (5.34cm) was noticed under control. Increased shoot diameter (0.34 cm) was recorded under the treatment B_2 (Borax @ 0.4%) and B_1 (Borax @ 0.2%) while, the minimum shoot diameter (0.33 cm) under control. The mean maximum number of leaves per shoot (24.77) was recorded under the treatment B_2(Borax @ 0.4%),followed by B_1 (Borax @0.2%) , while the minimum number of leaves per shoot (19.53) was recorded under control (B_0). the Borax has a key role in cell division and cell elongation, and there by increased vegetative growth. A notable characteristic of Borax is that it directly effect on photosynthesis activity of plants. Increase in shoot length due to spray of Borax have also been reported earliar by several workers. Bagali*et al.* (1993) reported that spray of borax singly and their combinations at 0.3 per cent concentration on guava cv. Sardar during June and July (winter season crop) enhanced the shoot length, number of leaves per shoot, number of flower buds per shoot, fruit set per shoot, fruit retention per shoot, physical parameters of fruits, number of fruits per tree and fruit yield per tree in guava.

(b) Yield attributes

The data pertaining to various yield attributing parameters of the guava plant viz. number of fruits per plant, weight of fruit, and yield of fruit per plant, yield per hectare, polar diameter of fruit,radial diameter of fruit, pulp weight, seed weight, significantly increased by the various sprays of Borax. The increased maximum number of fruits per plant (322), fruit weight (142.28 g), fruit yield per tree (46.08 kg), yield per hectare (127.96 q), polar diameter (7.03 cm), radial diameter (6.49 cm), and pulp weight (250 g) were recorded under the treatment B_2 (Borax @ 0.4%) and maximum seed weight were recorded under control (B0) which were significantly superior to the other levels whereas, the minimum number of fruits per plant (302), fruit weight (134.11 g) fruit yield per tree (40.77 kg) , yield per hectare (113.22 q), and radial diameter (6.05 cm) were recorded under control. The seed weight (1.74 g), pulp weight (168.00g), and pollar diameter (6.06cm) were recorded under treatment B1 (Borax @ 0.2%).The increase in fruit yield may be attributed to the increase in vegetative growth Whole enhancement in yield and yield attributing parameters may be due to the increased auxin production and subsequent translocation from source to sink. Borax acts as catalyst in the oxidation and reduction processes and also has great importance in the sugar metabolism, it might have improved the physical characters of guava fruit and thus increased the yield per tree assumed in our finding. Heavier fruits with more fruit weight under Borax treatment might be due to the high level of auxin in the various parts of the fruit plant maintained by Borax. Borax spray increased the fruit weight because it is an essential micro nutrient and it is considered indispensable for the growth of all organism (Arora& Singh 1970). Chaitanya*et al.* (1997) and Pal et al. (2008) also observed that foliar spray of borax improved the fruit yield in guava cv. L-49. Stampar*et al*. (1999) observed that foliar application of borax increased yield up to 30 per cent in apple.

(c) Bio-Chemical analysis of fruits

The bio-chemical analysis of the guava plant non-significantly influenced by the different concentration of Borax over the control. The mean of maximum TSS (13.4^{0}Brix) were recorded under B_2(Borax @ 0.4%) and minimum acidity (0.22 %) of guava fruits were recorded under B_2 (Borax @ 0.4%). whereas minimum TSS (8.54^{0}Brix), and maximum acidity (0.30%) of guava fruits were recorded under control. Decrease in acidity due to treatment B_2(Borax @ 0.4%)

spray is in agreement with the observations of Rajput and Chand (1976). Increase in sugar, TSS, ascorbic acid, and sugars and reduced the acidity content in guava by Borax might be due to the active enzymatic reaction like transformation of carbohydrates, activity of hexokinase and formation of cellulose. The findings of the present investigation finds support from Rajput and Chand (1976), Singh *et al.* (1989) ,Ingle *et al.* (1993) and Banik*et al*. (1997) in guava.

(d) Organoleptic Parameters

The data pertaining to various organoleptic parameters of the guava plant viz. taste,colour and appearance,aroma and over allacceptibility significantly and non significantly increased by the various sprays of Borax.The taste was found to be significantly influenced due to the foliar spray of Borax. The maximum taste score (7.20) was recorded under treatment B_2(Borax @ 0.4%) followed by B1(Borax @ 0.2%) whereas, minimum taste score (6.66) under control (B_0).The colour and appearance was found to be non significantly influenced due to the foliar spray of Borax. The mean maximum colour and appearance score (6.33) was recorded under treatment B_2(Borax @ 0.4%) followed by B1(Borax @ 0.2%) whereas, minimum colour and appearance score (6.07) under control (B_0).The aroma was found to be significantly influenced due to the foliar spray of Borax. The mean maximum aroma score (6.40) was recorded under treatment B_2(Borax @ 0.4%) followed by B1(Borax @ 0.2%) whereas, minimum aroma score (6.04) under control (B_0).The over allacceptibility was found to be significantly influenced due to the foliar spray of Borax. The mean maximum over all acceptibility score (6.53) was recorded under treatment B_2 (Borax @ 0.4%) followed by B1(Borax @ 0.2%) whereas, minimum over all acceptibility score (6.22) under control (B_0).Bhatia *et al.* (2001) carried out studies on guava in which K_2SO_4 (0.5,1.0 and 1.5%),$ZnSO_4$(0.5,0.75 and 1.0%),H_3BO_3(0.3,0.5 and 1.0) and water (control) were sprayed on the trees during winter season crop at the stage when the fruit was of walnut size (25th of October) and second after 15 days.All the nutrients increased fruit weight and yield which was maximum (73.0kg per tree) with H_3BO_3 1.0%.The fruit pressure was minimum (10.1kg/cm2) with H_3BO_3 at 1.0%.The orgenolaptic rating out of 10 points was the highest (9.0) with K_2SO_4 at 1.5%.The total soluble solids and sugars were more with H_3BO_3 followed by K_2SO_4.Ascorbic acid was found maximum with K_3SO_4(182gm/100g).

(e) Post harvest Parameters

The data pertaining to various post harvest parameters of the guava plant viz. PLW%, fruit spoilage% and shelf life (days) significantly increased by the various sprays of Borax.The minimum physiological loss in weight was recorded 5.30% at 4 days with foliar application of Borax @ 0.4 (T_3). The maximum physiological loss in weight was recorded 7.10 per cent at 4 days under control (T_1).Minimum Spoilage % were observed (3.68 %) , (11.43 %) and (20.96%) on the 5th day , 10th day , and 15th day of storage were observed with treatments B_2 (Borax @ 0.4 %) . However the maximum decay per cent was recorded in the control.The maximum shelf life of fruit recorded 4.00 days with foliar spray of Borax @ 0.4% (T2). The minimum shelf life of fruit is recorded 2.00 days under control (T_1).No *et al.* (2007) focused on the application of chitoson for improvement of qualityand shelf life of various foods from agriculture, poultry and seafood origin.

(B)Effect of Zinc sulphate

(a) Growth Parameters

The growth parameters of the guava plant were significantly improved by the sprays of Zinc sulphate over the control. The maximum tertiary shoot length (7.19 cm) was recorded in Z_2 (ZnSo4 @ 0.6 %) and the minimum tertiary shoot length (4.26 cm) noticed under control. The increased (0.36 cm) shoot diameter was recorded in Z_2 (ZnSo4 @ 0.6%), which was superior to other treatments while, the minimum shoot diameter (0.33 cm) was recorded in the control. The mean maximum number of leaves per shoot (23.78) was recorded under the treatment Z_2 (ZnSo4 @ 0.6%),while the minimum number of leaves per shoot (18.94) was recorded under control (Z_0). It is clear from the findings of the study that Zinc sulphate significantly influenced the growth and yield attributes. Nitrogen is an important component of protoplasm helpful in chlorophyll synthesis. The increase in photosynthetic activity due to spray of Zinc sulphate and consequently Zinc sulphate stimulated the synthesis of endogenous hormones which prevents the abscission and facilitated the ovary to remain attached with the shoot, resulting in lower flower drop.

(b) Yield attributes

The data pertaining to various yield attributing parameters of the guava plant viz., number of fruits per plant, fruit weight, fruit yield per tree , yield per hectare,polar diameter, radial diameter, pulp weight and seed weight were significantly improved by the spray of Zinc sulphate. The maximum number of fruits per plant (322.5), fruit weight (142.72 g), yield per plant (46.25 kg) and yield per hectare (128.42 q), polar diameter (6.57 cm) , and radial diameter (6.5 cm) were recorded under the treatment Z_2 (ZnSo4@ 0.6%) , maximum pulp weight (217 g) under treatment Z1 (ZnSo4 @ 0.4), and maximum seed weight (2.56 g) under control (Z0) which were significantly superior to other levels of Zinc sulphate while, the minimum number of fruits per plant (300.33), fruit weight (132.28 g), fruit yield per tree (40.31 kg) , yield per hectare (111.95 q),polar diameter (6.21cm),radial diameter (6.13 cm) and pulp weight (174.87cm) noticed under control, Seed weight minimum (1.78 g) under treatment Z2(ZnSo4 @0.6%).Meena*et al.* (2005) studied the combined effect of foliar application of urea (2.0, 2.5 and 3.0%) and $ZnSO_4$ (0.5, 1.0 and 1.5%) on the fruit quality and yield of pruned guava (cv. Sardar) under high-density planting system and reported that foliar application of 3.0% urea + 1.0% $ZnSO_4$ increased fruit size, weight and pulp/seed ratio.

(c) Bio-chemical analysis of fruits

The chemical analysis of the guava plant were non-significantly influenced by the different concentration of Zinc sulphate over the control. The mean maximum TSS (11.89^{0}Brix), Z_1 (ZnSo4@ 0.4%) and minimum acidity (0.24) of guava were recorded under Z_2 (ZnSo4@ 0.6%). Whereas, the minimum TSS (10.44^{0}Brix), and maximum acidity (0.55) of guava were recorded under control.Prabu and Singaram (2001) reported the effect of Zn and B on the quality of grapes. The treatments were $ZnSO_4$ 0.5% (10 and 20 g per vine) and borax 0.2% (4 and 8 g), alone and in combinations. Foliar applications were conducted during the vegetative and full bloom stages. The TSS (15.8 degrees Brix), and sugar:acid ratio (10.84) were highest with ZnSO4 + borax treatments.

(d) Organoleptic Parameters

The data pertaining to various organoleptic parameters of the guava plant viz. taste,colour and appearance,aroma and over allacceptibility significantly and non significantly increased by the various sprays of Zinc sulphate.The taste was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum taste (7.03) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum taste (6.91), was recorded under the control (Z_0).The taste was found to be non significant due to the foliar spray of Zinc sulphate over the control. The mean maximum colour and appearance (6.23) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum colour and appearance (6.17), was recorded under the control (Z_0).The aroma was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum aroma (6.28) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum aroma (6.14), was recorded under the control (Z_0).The over allacceptibility was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum over all acceptability score (6.44) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum over all acceptability score (6.22), was recorded under the control (Z_0).

(e) Post harvest Parameters

The data pertaining to various post harvest parameters of the guava plant viz. PLW%, fruit spoilage% and self life (days) significantly and non significantly increased by the various sprays of Zinc sulphate.The minimum physiological loss in weight is recorded 4.90 per cent at 4 days with foliar application of Zinc sulphate @ 0.6 (T_5). The maximum physiological loss in weight was recorded 7.10 per cent at 4 days under control (T_1).Minimum Spoilage % were observed(3.23 %),(11.12%)and (20.56%) on the 5th day , 10th day , and 15th day of storage were observed with treatments Z2(ZnSo4 @ 0.6 %) . However, maximum spoilage % was recorded in the control. The maximum shelf life of fruit recorded 5.2 days with foliar spray of Zinc sulphate @ 0.6% (T_5). The minimum spoilage % was recorded 2.00 days under control (T1). Sanjay *et al.*

(2008)concluded that the anola fruit treated with GA_3 100 ppm or calcium nitrate 1.5 per cent and kept in perforated polythene bags could efficiently rate in the fruit quality till the last day of storage (13^{th} days) under ambient temperature.

(C) Interaction effect of Boron and Zinc sulphate

(a) Growth Parameters

The interaction effect of Borax and ZnSo4 were significantly improved the vegetative parameters of guava plant. The maximum tertiary shoot length (8.08 cm), were recorded under B_2Z_2 (Borax @ 0.4% & ZnSo4@ 0.6 %) followed by B_1Z_2 (Borax @ 0.2% & ZnSo4 @ 0.6%), whereas the minimum tertiary shoot length (3.70 cm) was recorded under control B_0Z_0. The maximum shoot diameter (0.38 cm) was recorded under B_2Z_2(Borax @ 0.4% & ZnSo4 @ 0.6%) while, the minimum shoot diameter (0.31 cm) under B_2Z_0 (Borax @ 0.4% & no ZnSo4). The mean maximum number of leaves per shoot (26.30) was recorded under B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6 %) followed by B_2Z_1 (Borax @ 0.4% & Znso4 @ 0.4%) while the minimum number of leaves per shoot (15.65) under the control (B_0 Z_0).The foliar sprays of chemical viz., B and Zn, might have induced the synthesis of chlorophyll.

(b) Yield Parameters

The combined sprays of Borax and Zinc sulphate showed great improvement in yield attributing characters of guava. The maximum number of fruit (322.5) was obtained under B_2Z_2(Borax @ 0.4% & ZnSo4@ 0.6%) while the minimum yield was obtained with control. The higher fruit weight (147.83 g), fruit yield per tree (48.71 kg) and fruit yield per hectare (135.29 q), polar diameter (7.33 cm), pulp weight (297.00 g) and minimum seed weight (1.69 g)were noted under B_2Z_2 (Borax @ 0.4% & ZnSo4@ 0.6 %), The maximum radial diameter (6.83 cm) was recorded under the treatment B_1Z_2 (Borax @ 0.2% & ZnSo4@ 0.6%)andThe maximum pulp weight (297.00 g) was recorded under the treatment B_2Z_1 (Borax @ 0.4% & ZnSo4@ 0.4%) , Whereas, the minimum number of fruit (289), fruit weight (128.67 g), fruit yield per tree (37.92 kg), fruit yield per hectare (105.31q), maximum seed weight (3.63 g) and minimum pulp weight (150 g) noticed under control. Minimum polar diameter (5.51 cm) was recorded under the treatment B_1Z_o(Borax @ 0.2% & control) . the minimum radial diameter (5.8 cm) was recorded under the treatment B_0 Z_1 (control &ZnSo4@ 0.4%) .Trivedi*et al*. (2012) evaluated the effect of zinc (Zn) and boron (B) on the yield and fruit quality of guava. The treatments comprised control (tap water; T_0), 0.5% boric Acid (T_1), 0.6% boric acid (T_2), 0.5% zinc sulfate (T_3), 0.5% zinc sulfate + 0.5% bori acid (T4), 0.5% zinc sulfate + 0.6% boric acid (T_5), 0.6% zinc sulfate (T_6), 0.6% zinc sulfate + 0.5% boric acid (T_7) and 0.6% zinc sulfate + 0.6% boric acid (T_8). Data were recorded on fruit weight and fruit diameter. It was noted that the combined foliar application of zinc sulfate (0.6%) and boric acid (0.5%) before and after fruit set resulted in higher fruit weight, radial diameter, polar diameter and specific gravity.

(b) Bio-chemical Parameters

The chemical analysis of guava fruits were non-significantly improved by the combined foliar sprays of Borax and Zincsulphatewe over the control. The maximum TSS (13.7^0Brix) under treatment B_2Z_2 (Borax @ 0.4 %& ZnSo4 @ 0.6 %), while the minimum TSS (7.3 ^{0}Brix) was recorded under control. All the nutrients at different concentration augmented TSS content of the fruit. Increase in TSS might be due to spray of Borax which helped in sugar transport and ultimate accumulation of more sugars and organic acids in fruits. The minimum acidity (0.43) was recorded under the treatment B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6%), while the maximum acidity was recorded under control.Singh and Brahmachari (1999) reported that total soluble solids and ascorbic acid contents of the fruit pulp enhanced markedly with the application of two levels of Zinc (0.5 and 1.0 per cent $ZnSO_4$). Application of 1.0 per cent $ZnSO_4$ resulted in significant reduction in acidity in guava fruit over 0.5% $ZnSO_4$ and control. The application of boron and zinc enhanced TSS considerably. The ascorbic acid content of the fruit pulp also increased greatly with the higher concentrations of boron and Zinc.

(d) Organoleptic Parameters

The organoleptic parameters of guava fruits were significantly and non-significantly improved by the combined foliar sprays of Borax and Zinc sulphatewe over the control.The interaction effect of Borax and Zinc sulphate on taste was found to be non significant. The maximum taste score (7.30) was recorded under treatment B_2Z_2 (Borax @ 0.4 % & Zinc sulphate @ 0.6 %)

followed by B_2Z_1 (Borax @ 0.4% & ZnSo4@ 0.4%), whereas the minimum taste score (6.50) was recorded under the control (B_0Z_0).The interaction effect of Borax and Zinc sulphate on taste and appearance was found to be non significant. The maximum colour and score (6.33) was recorded under treatment B2Z0(Borax @ 0.4 % & Zinc sulphate 0%) , B_2Z_1 (Borax @ 0.4 % & Zinc sulphate @ 0.4 %)B2Z2(Borax @ 0.4 % & Zinc sulphate 0.6%), followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%) , whereas the minimum colour and appearance score (6.03) was recorded under the control (B_0Z_0) andB0Z1(Borax @ 0% & Zinc sulphate@ 0.4%).The interaction effect of Borax and Zinc sulphate on aroma was found to be significant. The mean maximum aroma score (6.50) was recorded under treatment B2Z2(Borax @ 0.4 % & Zinc sulphate 0.6%), followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%) , whereas the mean minimum aroma score (6.03) was recorded under the control (B_0Z_0) andB0Z2(Borax @ 0% & Zinc sulphate 0.6%).The interaction effect of Borax and Zinc sulphate on over all acceptibility was found to be non significant. The mean maximum over all acceptibility score (6.70) was recorded under treatment B2Z2(Borax @ 0.4 % & Zinc sulphate 0.6%), followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%) , whereas the mean minimum over all acceptibility score (6.13) was recorded under the control (B_0Z_0).

(e) Post harvest Parameters

The combined sprays of Borax and Zinc sulphate showed great improvement in post harvest parameters of guava..The minimum physiological loss in weight is recorded 5.50% in T9(Borax @ 0.4% & ZnSo4 @ 0.6%). The maximum physiological loss in weight was recorded 7.10 per cent at 4 days under control (T_1).The minimum spoilage %(4.11 %), (11.11%)and (20.77%) was recorded with treatment B2Z2 (Borax @ 0.4 % + ZnSo4@ 0.6 %) at 5th, 10th and 15th day of storage respectively, However, the maximum spoilage % (7.72 %), (16.89 %) and (28.44 %) was recorded under control at 5th, 10th and 15th day of storage, respectively.The minimum self life days of fruit was recorded 3.30% in T9(Borax @ 0.4% & ZnSo4 @ 0.6%). The maximum self lifedays fruitwas recorded 7.10 per cent at 4 days under control (T_1).Kumar and Brahmachari (2006) reported that pre harvest application of different chemicals significantly reduced physiological loss in weight of fruit during stored. Spray of GA_3 200 ppm followed by $CaCl_2$ 2.0 per cent and Kinetin 50 ppm was most effective treatment in minimizing the physiological loos in weight.

Economics of different treatment

A critical examination of data presented in the previous chapter revealed thatvarious treatments of Borax and Zinc sulphate increased the net return and B:C ratio. Maximum net returns (Rs 2, 43,280/ ha) was recorded in B_2Z_2 (Borax @ 0.4% & Zinc sulphate @ 0.6 %) and the minimum (Rs 192674/ ha) in control. Whereas, minimum B:C ratio(1:8.00) was recorded with B_0Z_0 (no Borax % @ & no Zinc sulphate), while maximum (1:9.97) was in B_2Z_2 (Borax @ 0.4% & Zinc sulphate@ 0.6 %). Pal *et al.* (2008) advocated that foliar application of Zinc sulphate(0.4 per cent, 0.6 per cent), borax (0.2 per cent, 0.4 per cent) increased the length, breadth, weight, volume, TSS, ascorbic acid and reduced the acidity of fruit in guava cv. Sardar. Awasthi and Lal (2009) and Ali *et al.* (1993) also reported similar finding in guava fruits.

Chapter – VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

6.1. Summary

The experiment entitled, “Effect of foliar application of Borax and Zinc sulphate on growth, yield and quality of Guava *(Psidiumguajava*L.) cv. Gwalior-27” was carried out at the Agrotechnology Park of Krishi Vigyan Kendra, College of Agriculture, Rajmata VijayarajeScindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during 2016-2017**.** The results obtained and discussed in previous chapters are summarized below:

Significant and non significant improvement was recorded in the vegetative parameters (shoot length, shoot diameter,number of leaves), yield attributes (number of fruits per tree, average fruit weight, yield per tree, yield per hectare,radial diameter, polar diameter, seed weight and pulp weight),bio-chemical characteristics (TSS and Acidity) due to application of various chemicals over control. The results obtained from the present investigation are summarized below:

(A) Effect of Borax

The vegetative parameters of the guava plant were significantly influenced by the different concentration of Borax over the control. The mean maximum tertiary shoot length (6.43 cm), of guava were recorded under B_2 (Borax @ 0.4%), which was superior with other treatments whereas, the minimum tertiary shoot length (5.34 cm) noticed under control. Increased shoot diameter (0.34 cm) was recorded under the treatment B_1 (Borax @ 0.2%) and B_2 (Borax @ 0.4%) while, the minimum shoot diameter (0.33 cm) was recorded under control.The mean maximum number of leaves per shoot (24.77) was recorded under the treatment B_2 (Borax @ 0.4%),followed by B_1(Borax @0.2%) , while the minimum number of leaves per shoot (19.53) was recorded under control (B_0).

The data pertaining to various yield attributing parameters of the guava plant viz. number of fruits per plant, fruit weight, fruit yield per tree,radial diameter ,polar diameter,pulp weight and seed weight are significantly increased by the various sprays of Borax. The increased maximum number of fruits per plant (322), fruit weight (142.28 g), fruit yield per tree (46.08 kg), yield per hectare (127.96 q), polar diameter (7.03 cm), radial diameter (6.49 cm), and pulp weight (250 g) were recorded under the treatment B_2 (Borax @ 0.4%) and maximum seed weight were recorded under control (B0) which were significantly superior to the other levels whereas, the minimum number of fruits per plant (302), fruit weight (134.11 g) fruit yield per tree (40.77 kg) , yield per hectare (113.22 q), and radial diameter (6.05 cm) were recorded under control. The seed weight (1.74 g), pulp weight (168.00g), and pollar diameter (6.06cm) were recorded under treatment B1 (Borax @ 0.2%)

The chemical parameters of the guava plant were non-significantly and significantly influenced by the different concentration of Borax over the control. The mean maximum TSS (13.7^{0}Brix) was recorded under B_1 (Borax @ 0.2%) and minimum acidity (0.20 %) of guava fruits was recorded under B_2 (Borax @ 0.4%). whereas The minimum TSS (7.3 ^{0}Brix), and maximum acidity (0.37%) of guava fruits were recorded under control.

The data pertaining to various organoleptic parameters of the guava plant viz. taste,colour and appearance,aroma and over allacceptibility significantly and non significantly increased by the various sprays of Borax.The taste was found to be significantly influenced due to the foliar spray of Borax. The maximum taste score (7.20) was recorded under treatment B_2 (Borax @ 0.4%) followed by B1(Borax @ 0.2%) whereas, minimum taste score (6.66) under control (B0).Thecolour and appearance was found to be non significantly influenced due to the foliar spray of Borax. The mean maximum colour and appearance score (6.33) was recorded under treatment B_2 (Borax @ 0.4%) followed by B1(Borax @ 0.2%) whereas, minimum colour and appearance score (6.07) under control (B0).The aroma was found to be significantly influenced due to the foliar spray of Borax. The mean maximum aroma score (6.40) was recorded under treatment B_2 (Borax @ 0.4%) followed by B1(Borax @ 0.2%) whereas, minimum aroma score (6.04) under control (B0).Theover allacceptibility was found to be significantly influenced due to the foliar spray of Borax. The mean maximum over all acceptibility score (6.53) was recorded under treatment B_2 (Borax @ 0.4%)

followed by B1(Borax @ 0.2%) whereas, The minimum over all acceptibility score (6.22) was recorded under control (B0).

The data pertaining to various post harvest parameters of the guava plant viz. PLW%, fruit spoilage% and shelf life (days) significantly and non significantly increased by the various sprays of Borax..The minimum physiological loss in weight is recorded 5.30% at 4 days with foliar application of Borax @ 0.4 (T_3). The maximum physiological loss in weight was recorded 7.10 per cent at 4 days under control (T_1).Minimum Spoilage % were observed (3.68 %) , (11.43 %) and (20.96%) on the 5^{th} day , 10^{th} day , and 15^{th} day of storage were observed with treatments B_2(Borax @ 0.4 %) . however maximum decay per cent was recorded in the control.The maximum shelf life of fruit was recorded 4.00 days with foliar spray of Borax @ 0.4% (T2). The minimum shelf life of fruit is recorded 2.00 days under control (T1).

(B) Effect of Zinc sulphate

The vegetative parameters of the guava plant were significantly improved by the sprays of Zinc sulphate over the control.The maximum tertiary shoot length (7.19 cm) was recorded in Z_2 (ZnSo4 @ 0.6 %) and the minimum tertiary shoot length (4.26 cm) noticed under control. The increased (0.36 cm) shoot diameter was recorded in Z_2 (ZnSo4 @ 0.6%), which was superior to other treatments while, the minimum shoot diameter (0.33 cm) was recorded in the control. The mean maximum number of leaves per shoot (23.78) was recorded under the treatment Z_2 (ZnSo4 @ 0.6%),while the minimum number of leaves per shoot (18.94) was recorded under control (Z_0).

The data pertaining to various yield attributing parameters of the guava plant viz. number of fruits per plant, fruit weight, fruit yield per tree and yield per hectare, radial diameter, polar diameter,seed weight and pulp weight were significantly improved by the spray of Zinc sulphate. . The maximum number of fruits per plant (322.5), fruit weight (142.72 g), yield per plant (46.25 kg) and yield per hectare (128.42 q), polar diameter (6.57 cm) and radial diameter (6.5 cm) were recorded under the treatment Z_2 (ZnSo4 @ 0.6%) , The maximum pulp weight (217 g) under treatment Z1 (ZnSo4 @ 0.4), and maximum seed weight (2.56 g) under control (Z0) which were significantly superior to other levels of Zinc sulphate while, the minimum number of fruits per plant (300.33), fruit weight (132.28 g), fruit yield per tree (40.31 kg) , yield per hectare (111.95 q),polar diameter (6.21cm),radial diameter (6.13 cm) and pulp weight (174.87cm) noticed under control, The minimum Seed weight (1.78 g) under treatment Z2 (ZnSo4 @0.6%).

The Bio-chemical parameters of the guava plant were non-significantly and significantly influenced by the different concentration of Zinc sulphate over the control. The mean maximum TSS (11.89^{0}Brix), was noted on treatment Z_1 (ZnSo4@ 0.4%) and The minimum acidity (0.24) of guava were recorded under Z_2 (ZnSo4@ 0.6%). Whereas, the minimum TSS (10.44^{0}Brix), and The maximum acidity (0.55) of guava were recorded under control.

The data pertaining to various organoleptic parameters of the guava plant viz. taste,colour and appearance,aroma and over allacceptibility significantly and non significantly increased by the various sprays of Zinc sulphate.The taste was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum taste (7.03) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum taste (6.91), was recorded under the control (Z_0).The taste was found to be non significant due to the foliar spray of Zinc sulphate over the control. The mean maximum colour and appearance (6.23) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum colour and appearance (6.17), was recorded under the control (Z_0).The aroma was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum aroma (6.28) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum aroma (6.14), was recorded under the control (Z_0).The over allacceptibility was found to be significant due to the foliar spray of Zinc sulphate over the control. The mean maximum over all acceptability score (6.44) was recorded under treatment Z_2(ZnSo4@ 0.6%), followed by Z_1 (ZnSo4 @ o.4%), while the minimum over all acceptability score (6.22), was recorded under the control (Z_0).

The data pertaining to various post harvest parameters of the guava plant viz. PLW%, fruit spoilage% and shelf life (days) significantly and non significantly increased by the various sprays of Zinc sulphate.The minimum physiological loss in weight was recorded 4.90 per cent at 4 days with foliar application of Zinc sulphate @ 0.6 (T_5). The maximum physiological loss in weight was recorded 7.10 per cent at 4 days under control (T_1).Minimum Spoilage % were observed (3.23 %),(11.12%)and (20.56%) on the 5th day , 10th day , and 15th day of storage were observed with treatments Z2(ZnSo4 @ 0.6 %) . However, The maximum spoilage % was recorded in the control. The maximum self life of fruit recorded 5.2 days with foliar spray of Zinc sulphate @ 0.6% (T5). The minimum spoilage % was recorded 2.0 days under control (T1).

(C) Interaction effect of Borax and Zinc sulphate

The interaction effect of Borax and Zinc sulphate were non- significantly and significantly improved the vegetative parameters of guava plant. The maximum tertiary shoot length (8.08 cm), were recorded under B_2Z_2 (Borax @ 0.4% & ZnSo4@ 0.6 %) followed by B_1Z_2 (Borax @ 0.2% & ZnSo4 @ 0.6%), whereas minimum tertiary shoot length (3.70 cm) were recorded under control B_0Z_0. The maximum shoot diameter (0.38 cm) were recorded under B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6%) while, the minimum shoot diameter (0.31 cm) under B_2Z_0 (Borax @ 0.4% & no ZnSo4). The mean maximum number of leaves per shoot (26.30) was recorded under B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6 %) followed by B_2Z_1 (Borax @ 0.4% & Znso4 @ 0.4%) while the minimum number of leaves per shoot (15.65) under the control (B_0 Z_0).

The yield attributes of guava fruits were non-significantly improved by the combined sprays of Borax and Zinc sulphate over the control. The maximum number of fruit (322.5) was obtained under B_2Z_2 (Borax @ 0.4% & ZnSo4@ 0.6%) whereas the minimum number of fruit weight obtained with control. The higher fruit weight (147.83 g), fruit yield per tree (48.71 kg) and fruit yield per hectare (135.29 q), polar diameter (7.33 cm), pulp weight (297.00 g) and minimum seed weight (1.69 g)were noted under B_2Z_2 (Borax @ 0.4% & ZnSo4@ 0.6 %), The maximum radial diameter (6.83 cm) was recorded under the treatment B_1Z_2 (Borax @ 0.2% & ZnSo4@ 0.6%) and the maximum pulp weight (297.00 g) was recorded under the treatment B_2Z_1 (Borax @ 0.4% & ZnSo4@ 0.4%) , Whereas, the minimum number of fruit (289), fruit weight (128.67 g), fruit yield per tree (37.92 kg), fruit yield per hectare (105.31q), maximum seed weight (3.63 g) and minimum pulp weight (150 g) were noticed under control. Minimum polar diameter

(5.51 cm) was recorded under the treatment B_1Z_0(Borax @ 0.2% & control) . the minimum radial diameter (5.8 cm) was recorded under the treatment B_0 Z_1 (control& ZnSo4@ 0.4%) .

The chemical attributes of guava fruits were non-significantly improved by the combined sprays of Borax and Zinc sulphate over the control. The maximum TSS (13.7^{0}Brix) under treatment B_2Z_2 (Borax @ 0.4 %& ZnSo4 @ 0.6 %), while the minimum TSS (7.3 ^{0}Brix) was recorded under control. All the nutrients at different concentration augmented TSS content of the fruit. Increase in TSS might be due to spray of Borax which helped in sugar transport and ultimate accumulation of more sugars and organic acids in fruits. The minimum acidity (0.43) was recorded under the treatment B_2Z_2 (Borax @ 0.4% & ZnSo4 @ 0.6%), while the maximum acidity was recorded under control.

The organoleptic parameters of guava fruits were significantly and non-significantly improved by the combined foliar sprays of Borax and Zincsulphatewe over the control.The interaction effect of Borax and Zinc sulphate on taste was found to be non significant. The maximum taste score (7.30) was recorded under treatment B_2Z_2 (Borax @ 0.4 % & Zinc sulphate @ 0.6 %) followed by B_2Z_1 (Borax @ 0.4% & ZnSo4@ 0.4%), whereas the minimum taste score (6.50) was recorded under the control (B_0Z_0).The interaction effect of Borax and Zinc sulphate on taste and appearance was found to be non significant. The maximum colour and appearance score (6.33) was recorded under treatment B2Z0(Borax @ 0.4 % & Zinc sulphate 0%) , B_2Z_1 (Borax @ 0.4 % & Zinc sulphate @ 0.4 %) B2Z2 (Borax @ 0.4 % & Zinc sulphate 0.6%), followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%) , whereas the minimum colour and appearance score (6.03) was recorded under the control (B_0Z_0) and B0Z1 (Borax @ 0% & Zinc sulphate 0.4%).The interaction effect of Borax and Zinc sulphate on aroma was found to be significant. The mean maximum aroma score (6.50) was recorded under treatment B2Z2 (Borax @ 0.4 % & Zinc sulphate 0.6%), followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%) , whereas the mean minimum aroma score (6.03) was recorded under the control (B_0Z_0) and B0Z2 (Borax @ 0% & Zinc sulphate 0.6%).The interaction effect of Borax and Zinc sulphate on over all acceptibility was found to be non significant. The mean maximum over all acceptibility score (6.70) was recorded under treatment B2Z2(Borax @ 0.4 % & Zinc sulphate

0.6%), followed by B_1Z_1 (Borax @ 0.2% & ZnSo4@ 0.4%) , whereas the mean minimum over all acceptibility score (6.13) was recorded under the control (B_0Z_0).

The combined sprays of Borax and Zinc sulphate showed great improvement in post harvest parameters of guava.The minimum physiological loss in weight is recorded 5.50% in T9(Borax @ 0.4% & ZnSo4 @ 0.6%). The maximum physiological loss in weight was recorded 7.10 per cent at 4 days under control (T_1).The minimum spoilage %(4.11 %), (11.11%)and (20.77%) was recorded with treatment B2Z2 (Borax @ 0.4 % + ZnSo4@ 0.6 %) at 5^{th}, 10^{th} and 15^{th} day of storage respectively, However, the maximum spoilage % (7.72 %), (16.89 %) and (28.44 %) was recorded under control at 5^{th}, 10^{th} and 15^{th} day of storage, respectively.The minimum shelf life days of fruit was recorded 3.30% in T9(Borax @ 0.4% & ZnSo4 @ 0.6%). The maximum shelf life days fruitwas recorded 7.10 per cent at 4 days under control (T_1).

(D) Economics of different treatment

The higher benefit cost ratio was obtained under B_2Z_2 (Borax @ 0.4% & Zinc sulphate @ 0.6%).

6.2. Conclusions

On the basis of results obtained in present investigation entitled **"Effect of foliar application of Borax and Zinc sulphate on growth, yield and quality of Guava *(Psidiumguajava*L.)cv. Gwalior-27"** it is concluded that foliar spray of Borax, Zinc sulphate and their interaction had significantly improved the growth parameters, yield attributes, bio- chemical analysis of fruits, organoleptic parameters and post harvestparameters.Individual spray of Borax i.e. B_2 (Borax @ 0.4%) and Zinc sulphate i.e. Z_2 (Zinc sulphate @ 0.6%) were found to be the best treatments for almost all the growth, quality and yield attributing characters of guava.

In the interaction effect of Borax and Zinc sulphate, the treatment B_2Z_2 (Borax @ 0.4% & Zinc sulphate @ 0.6 %) were found to be the best treatments for almost all the growth parameters, yield attributes bio-chemical analysis of fruits, organoleptic parameters and post harvest parameters.

6.3. Suggestions for further work

The following suggestions have been proposed for further work on the basis of present study.

- The present investigation should be repeated to confirm the findings.
- The experiment should be done with different concentration of Borax and Zinc sulphate to find out the best combination.
- The effect of Borax and Zinc sulphate on other varieties of guava may be exploited.
- Since, it was the first year of the trial, it is suggested that in order to confirm the validity of results, the experiment must be repeated over years.

BIBLIOGRAPHY

Abdollahi, M., Eshghi, S. and Tafazoli, E. (2010) Interaction of paclobutrazol, boron andzinc on vegetative growth, yield and fruit quality of strawberry (*Fragariaxananassa*Duch. cv. Selva).*Journalof Biological & Environmental Sciences*,**4**(11):67-75.

Anonymous (2014). Horticulture Database, National Horticulture Board,Gurgaon,Haryana.

Awasthi, P. and Lal, S. (2009). Effect of calcium, boron and zinc foliar sprays on the yield and quality of guava (*Psidiumguajava L*.). *Pantnagar J. Res*.,**7**(2):223-225.

Babu, N. and Singh, A. R. (1998).Effect of boron, zinc and copper sprays on growth and development of Litchi fruits.*Punjab Horticulture Journal*.**34**(3-4): 75-79.

Bagali, A. N; Hulamani, N. C. and Sulikeri, G. S. (1993).Effect of foliar application of zinc, magnesium and boron on growth and yield of guava (*Psidiumguajava* L.) cv. Sardar.*Karnataka J. Agric. Sci.***6** (2): 137-141.

Balakrishnan, K. (2000). Foliar spray of zinc, iron, boron and magnesium on vegetative growth, yield and quality of guava.*Ann. Plant Physiol.***14** (2): 151-153.

Balakrishnan, K. (2001). Effect of foliar application of micronutrients on guava.*MadrasAgric.J*.**88**(4/6): 316-317.

Banik, B.C.; Sen, S.K. and Bose, T.K. (1997).Effect of Zinc, Iron and Boron in combination with urea on growth, flowering, fruiting and quality of mango cv. Fazli, *Environ.Ecol.***15**(1): 122-125.

Bhatia, S.K., Yadav,S., Ahlawat V.P. and Dahiya, S.S. (2001). Effect of foliar application of nutrients on the yield and fruit quality of winter season guava cv. L-49.*Haryana. J. Hort. Sci.* **30**(1&2): 6-7.

Bose, T.K. and Sanyal,D.(2001).Fruits: Tropical and Sub tropical.NayaUdyog,Calcutta.

Chaitanya, C.G; Kumar, G; Rana B.L. and Mathew, A.K. (1997).Effect of foliar application of zinc and boron on yield and quality of guava (*Psidiumguajava* L.) cv. L-49.*Haryana. J. Hort. Sci*. **26** (1-2): 78-80.

Dahiya, S.S; Joon, M.S. and Daulta, B.S. (1993).Effect of foliar application of micronutrients on yield and quality of guava (*Psidiumguajava* L.) cv. L-49.*Indian J. Trop. Agric.* **11**(4): 284-286.

Das, A.,Majumdar, K. and Majumdar, B.C. (2001). Zinc sulphate induced higher sweetness of rainy season Guava fruits. *Indian Agric.***44** (3&4): 199-201.

Dutta, P. and Banik, A.K. (2007). Effect of foliar feeding of nutrients and plant growth regulators on physico-chemical quality of Sardar Guava grown in red and leteratictract of West Bengal. *Acta Hort*. **75**(I): 407-411.

EL-Sherif, A.A:,Saeed, W.T.andNouman, V. F. (2000). Effect of foliar application of potassium and Zinc on behaviour of MontaKhab-EL-Kanater guava tree.Bulletin of Faculty of Agriculture, University of Cairo.**51**(1): 73-84.

Goswami, A.K., Shukla, H.S., Kumar, P. and Mishra, D.S. (2012). Effect of pre-harvest application of micro-nutrients on quality of guava (*Psidiumguajava* L.) cv..Sardar.*Hortflora Research Spectrum.***1**(1): 60-63.

Ingle, K. G; Khan, M.A.H. and Kshirsagar, R.E. (1993).Effect of foliar application of nutrients on yield and quality of guava (*Psidiumguajava* L.) cv. L-49.*P. K. V.Res. J.* **17**(1): 78-80.

Katiyar, P.N., Singh, J.P. and Singh, P.C. (2009).Effect of nutrients and plant growth regulators on physico-chemical parameters and yield of Guava (*Psidiumguajava* L.) cv. AllahbadSafeda.*Inter. J. Agric. Sci*. **5**(10): 173-174.

Kaul, O.P. and Mathew, A.K. (1999). Effect of foliar spray of calcium nitrate, zinc sulphate and ethrel on the fruit characteristic of Floridasun peach (*Prunuspersica*Batch). *Adv. Pl. Sci*. **120** (2): 577-518.

Khan, A. S., Waseem Ullah, Malik, Rashid, A.U. Ahmad, Saleem, B. A. and Rajwana, I. A. (2012) Exogenous applications of boron and zinc influence leaf nutrient status,tree growth and fruit quality of Feutrell's Early (*Citrus reticulata* Blanco).*Pakistan J. Agri. Sci.* **49**(2): 113-119.

Kumar, A. and Brahamachari, (2006). Effect of pre harvest application of various chemicals on ripening and shelf life of banana cv. Harichhal (AAA). *The Orrisa J. of Hort.,***34**(2):93-102.

Kumar, Raj, Tiwari, J.P. and Lal, Shant (2010). Influence of zinc sulphate and boric acid spray on vegetative growth and yield of winter season guava (*Psidiumguajava L.*) cv. *Pant Prabhat. J. Res*., **8** (1) : 135-138.

Kumar, S.; Kumar, S. and Verma D.K. (2004).Effect of micro-nutrients and NAA on yield and quality of Litchi [(*Litchi chinensis*Garentn) Sonnj cv. Debradoon.Abst in Proc. of International Seminar on Recent Trend in Hi-tech Hort. and PHT, originated by C.S.A.U.A&T. Kanpur, Feb.4-6: 193.

Kundu, S. and Mitra S.K. (1999).Response of guava to foliar spray of copper, boron and zinc.*Indian Agric.***43** (1&2): 49-54.

Lal, G. and Sen, N.L. (2002). Flowering and fruiting of guava (*Psidiumguajava* L.) cv. Allahabad Safeda as influenced by application of nitrogen, zinc and manganese. *J.Eco. Physiol*.**5**(3/4): 87-91. 47.

Lone, I. A. (2007) Combined effect of soil and foliar application of boron and calcium onyield and quality of apple cv. Red Delicious. *AsianJ. Soil Sci.***2** (1): 40-42.

Maksoud, M. A; Amera, A. F; Fekrya, H. K. and Lailia, F. H. (2004) Effect of boronfertilization on growth, yield and fruit quality of olives.*ArabUniversities J. Agril.Sci.* **12**(1): 361-369.

Meena, R. P; Mohammed, S.andLakhawat, S. S. (2005). Effect of foliar application of urea and zinc sulphate on fruit quality and yield of pruned guava trees (*Psidiumguajava*L.) cv. 'Sardar' under high density planting system. *J. Hort. Sci*.**11**: 290-93.

No, H.K.; Meyers, S.P.; Prinyawiwatkul, W. and Xu, Z. (2007). Application of chitoson for improvement of quality and shelf life of food.*J. of Food Sci.***72** (5) R 87- R 100.

Patel, N.; Pandey, S.K. and Jain P.K. (2013).Effect of growth promoting substances and PGRs on fruit retention, drop and yield of acid lime (*Citrus aurantifolia*Swingle) cv. Kagzi.*JNKVV Res J.* **47**(1): 70-75.

Prabu, P. C. and Singaram, P. (2001).Effect of foliar and soil application of zinc andboron on yield and quality of grapes *cv.* Muscat. *Madras Agril. J.***88**: 7/9, 505-507.

Pradeep, W. and Sharma, O.N. (1997).Effect of soil and foliar application of zinc on yield and quality of Kinnow.*Haryana J. Hort. Sci*. **23**(13-14): 213-2 15.

Prasad,B; Das, S; Chatterjee,D; and Singh, U.P.(2005). Effect of foliar application of urea, zinc and boron on quality of guava.*J. Ap. Biol*. **15**: (1) 48-50.

Raghava, M. and Tiwari, J. P. (1998) Effect of boron on growth, quality and shelf-life offruits of guava (*Psidiumguajava* L.) cv. Sardar.*Prog.Hort.***30**: 1/2, 68-72.

Rajput, B.S.; Lekhe, R.; Sharma, G. and Singh, I. (2008).Effect of pre and post harvest treatment on shelf life and quality of guava (*Psidiumguajava*L.) cv. Gwaliar-27 *Asian J. Hort.,* **3** (2):368-371.

Sandhu, A. S.; Singh S. S., Mann; G.P.,Grewal, and Sagar, D. (1994). Influence of sources of zinc on growth and nutrient status of sand pear (*Pyruspyrfolia*Braum. Nobai.), Sixth International Symp. on Pear growing Med. Ford, Oregon, U.S.A. 12-14, 1993, *Acta Hort*. **367**: 323-328.

Sanjay, Singh; Singh, A.K.; Joshi, H.K. and Apparao, V.B. (2008).Effect of various post harvest treatments on shelf life of anola cv. Chakaiya.*Orrisa J. of Hort.***36** (1) 8-15.

Sarolia, D. K.; Rathore, N. S. and Rathore, R. S. (2007). Response of Zinc sulphate and Iron sulphate spray on growth and productivity of guava (*Psidiumguajava* L.) cv. Sardar*Curr. Agri*. **31**(1-2): 73-77.

Sharma, R. K; Kumar, R. and Thakur, S. (1991). Effect of foliar feeding of potassium, calcium and zinc on yield and quality of guava. *Indian J. Hort*, **48** (4)**:** 312-314.

Shukla, A. K. (2011). Effect of foliar application of calcium and boron on growth,productivity and quality of Indian gooseberry (*Emblicaofficinalis*).*IndianJ.Agricl. Sci.***81** (7): 628-632.

Shukla, A.K; Kaushik, R.A; Pandey, D. and Sarolia, D.K. (2008). In: Guava. Published by Maharana Pratap University of Agriculture and Technology, Udaipur, pp:7.

Singh, R.S. and Vashistha, (1997).Effect of foliar spray of nutrients on fruit drop, yield and quality of ber cv. Seb.*Haryana J. Hort .Sci*. **26**(1-2): 20-24.

Singh, R; Chaturvedi, O.P. and Singh, R. (2004). Effect of pre-harvest spray of Zinc, boron and calcium on the physico- chemical quality of guava fruits (*Psidiumguajava*L.).*International seminar on resent trend on Hi-tech. Hort. and P.H. T. Kanpur,* Feb 4-6, 2004:204.

Singh, R; Sharma, R. R; Moretti, C. L; Kumar, A. and Gupta, R. K. (2009) Foliarapplication of calcium and boron influences physiological disorders, fruit yieldand quality of strawberry (*F.* x *ananassa*Duch.). *ActaHort*.**842**: 835-838.

Singh, U.P. and Brahmachari V.S. (1999).Effect of potassium, zinc, boron and molybdenum on the physico-chemical composition of guava (*Psidiumguajava* L.) cv. Allahabad Safeda.*Orissa J. Hort.***27** (2): 62-65.

Stampar, F; Hudina M. and Dolence, K. (1999). Influence of foliar fertilizer on yield and quality of apple (*Mallusdomestica*Borkh.) Kumar Academic Publisher, pp. 91-94.

Suresh, S. and Prabha, A. C. S. (2005). Influence of liming and nutrients on the changes in pH, nutrients availability and yield of wetland banana in a flooded valley Fe toxic soil. *International J. Agri. Sci.,* **1 (1):** 65-68.

Trivedi.N., Singh D., Bahadur V., Prasad V. M. and Collis J.P. (2012). Effect of foliar application of zinc and boron on yield and fruit quality of guava (*Psidiumguajava* L.). *Hortflora Research Spectrum*, **1** (3): 281-283.

Wahid, A; Pathak, R.A. and Yadav, A. L. (1993) Effect of foliar applicationof nutrients on guava (*Psidiumguajava* L.) cv. Allahabad Safeda. *Prog. Hort.***23**: (1-4) 18-21.

Waskela, R.S., Kanpure, R.N., Kumawat, B.R. and Kachouli, B.K. (2013) Effect of foliar spray of micronutrients on growth, yield and quality of guava (*Psidiumguajava*L.) cv. Gwalior 27. *Intern. Jour. Agric. Scie*. **9**(2):551-556.

Yadav, H.C.; Yadav, A.L.; Yadav, D.K. and Yadav P.K. (2011).Effect of foliar application of micronutrients and GA3 on fruit yield and quality of rainy season guava.*Pl.Arch.***11**(1): 147-149.

APPENDICES

Appendix- I: Analysis of variance on tertiary shoot length (cm)

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.132674	0.066337	**6.53**		
B	2	5.422763	2.711381	**266.81**	3.63	6.23
Z	2	39.5515	19.77575	**1946.04**		
B*Z	4	0.868326	0.217081	**21.36**	3.01	4.77
Error	16	0.162593	0.010162			
Total	26					

Appendix- II: Analysis of variance on shoot Diameter (cm)

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.000585	0.000293	**1.15**		
B	2	0.000363	0.000181	**0.71**	3.63	6.23
Z	2	0.004274	0.002137	**8.38**		
B*Z	4	0.003881	0.00097	**3.80**	3.01	4.77
Error	16	0.004081	0.000255			
Total	26					

*** Significant at 5 % level**

Appendix- III : Analysis of variance on

ANOVA						
SV	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.382222	0.191111	**1.57**		
B	2	155.4649	77.73243	**637.70**	3.63,	6.23
Z	2	105.2388	52.61938	**431.68**		
B*Z	4	16.70031	4.175078	**34.25**	3.01,	4.77
Error	16	1.950311	0.121894			
Total	26					

no. of leaves per shoot

Appendix- IV: Analysis of variance on no. of fruits per plant

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	2.805119	1.402559	**0.17**		
B	2	135.5777	67.78885	**8.45**	3.63	6.23
Z	2	102.5458	51.2729	**6.39**		
B*Z	4	0.448948	0.112237	**0.01**	3.01	4.77
Error	16	128.3383	8.021143			
Total	26					

Appendix- V: Analysis of variance on average fruits weight (g)

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	62.2963	31.14815	**0.98**		
B	2	323.463	161.7315	**5.09**	3.63	6.23
Z	2	490.963	245.4815	**7.72**		
B*Z	4	14.03704	3.509259	**0.11**	3.01	4.77
Error	16	508.7037	31.79398			
Total	26					

Appendix- VI: Analysis of variance on fruit yield kg/ tree

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	9.931252	4.965626	**1.13**		
B	2	131.346	65.67299	**14.89**	3.63	6.23
Z	2	159.6591	79.82956	**18.10**		
B*Z	4	1.801837	0.450459	**0.10**	3.01	4.77
Error	16	70.58415	4.411509			
Total	26					

Appendix- VII: Analysis of variance on fruit yield q/ ha

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	75.97454	37.98727	**1.12**		
B	2	1014.375	507.1874	**14.91**	3.63	6.23
Z	2	1229.6	614.7999	**18.08**		
B*Z	4	13.74435	3.436087	**0.10**	3.01	4.77
Error	16	544.1174	34.00734			
Total	26					

Appendix- VIII: Analysis of variance on pollar diameter of fruit (cm)

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.218156	0.109078	**0.88**		
B	2	5.439356	2.719678	**21.86**	3.63	6.23
Z	2	0.587622	0.293811	**2.36**		
B*Z	4	3.050556	0.762639	**6.13**	3.01	4.77
Error	16	1.990178	0.124386			
Total	26					

Appendix- IX: Analysis of variance on radial diameter (cm)

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.654719	0.327359	**3.18**		
B	2	2.054674	1.027337	**10.00**	3.63	6.23
Z	2	3.232919	1.616459	**15.73**		
B*Z	4	1.098148	0.274537	**2.67**	3.01	4.77
Error	16	1.644548	0.102784			
Total	26					

Appendix- X: Analysis of variance on pulp weight (g)

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	25.24741	12.6237	**12.64**		
B	2	35908.85	17954.42	**17977.73**	3.63	6.23
Z	2	8527.114	4263.557	**4269.09**		
B*Z	4	6652.628	1663.157	**1665.32**	3.01	4.77
Error	16	15.97926	0.998704			
Total	26					

Appendix- XI: Analysis of variance on acidity

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.005119	0.002559	**4.41**		
B	2	0.03623	0.018115	**31.23**	3.63	6.23
Z	2	0.021719	0.010859	**18.72**		
B*Z	4	0.00037	9.26	**0.16**	3.01	4.77
Error	16	0.009281	0.00058			
Total	26					

Appendix- XII: Analysis of variance on TSS

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.002022	0.001011	**3.25**		
B	2	0.027467	0.013733	**44.14**	3.63	6.23
Z	2	0.024867	0.012433	**39.96**		
B*Z	4	0.014133	0.003533	**11.36**	3.01	4.77
Error	16	0.004978	0.000311			
Total	26					

Appendix- XIII: Analysis of variance on taste of fruits

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.054074	0.027037	**2.96**		
B	2	1.48963	0.744815	**81.66**	3.63	6.23
Z	2	0.071852	0.035926	**3.94**		
B*Z	4	0.119259	0.029815	**3.27**	3.01	4.77
Error	16	0.145926	0.00912			
Total	26					

Appendix- XIV: Analysis of variance on colour and appearance of fruits

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.038519	0.019259	**14.34**		
B	2	0.320741	0.16037	**119.45**	3.63	6.23
Z	2	0.020741	0.01037	**7.72**		
B*Z	4	0.028148	0.007037	**5.24**	3.01	4.77
Error	16	0.021481	0.001343			
Total	26					

Appendix- XV: Analysis of variance on aroma of fruits

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.094074	0.047037	**16.39**		
B	2	0.571852	0.285926	**99.61**	3.63	6.23
Z	2	0.080741	0.04037	**14.06**		
B*Z	4	0.041481	0.01037	**3.61**	3.01	4.77
Error	16	0.045926	0.00287			
Total	26					

Appendix- XVI: Analysis of variance on over all acceptibility

ANOVA						
S.V	**d.f.**	**SS**	**MS**	**Fcal**	**Ftab 5%**	**Ftab 1%**
REP	2	0.094074	0.047037	**1.64**		
B	2	0.447407	0.223704	**7.79**	3.63	6.23
Z	2	0.116296	0.058148	**2.03**		
B*Z	4	0.161481	0.04037	**1.41**	3.01	4.77
Error	16	0.459259	0.028704			
Total	26					

VITA

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2.	Higher Secondary	BSER	2011	56.77%	II[nd]
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I have submitted my thesis in 2016-2017, during his course work in partial fulfillment of the requirement for the degree of M.Sc. (Hort.) in Fruit Science.

Date: …………..

Place: …………..

(KomalYadav)