Effect of foliar spray of zinc, magnesium and boron on growth, yield and quality of Guava (*Psidium guajava* L.)

THESIS

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Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya

In partial fulfillment of the requirements for the Degree of

MASTER OF SCIENCE

IN

AGRICULTURE

HORTICULTURE (FRUIT SCIENCE)

By

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2019

CERTIFICATE- I

This is to certify that the thesis entitled "**Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** *submitted in partial fulfillment of the requirements for the Degree* of **MASTER OF SCIENCE** in **HORTICULTURE (Fruit Science)** *of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior is a record of the bona-fide research work carried out by* **Mr**. **Rajesh Chouhan** *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 this investigation has been acknowledged by the scholar.

Place: Gwalior **(Dr. K. S. Tomar)**

Date: **Chairman of the Advisory Committee**

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Member (Dr. Rajni Singh Sasode): ……

Member (Dr**.** P. S. Tomar) : ……..…

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Member (Dr. V.B. Singh) : …….

CERTIFICATE- II

This is to certify that the thesis entitled **"Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** *submitted by* **Mr. RAJESH CHOUHAN** *to the Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior in partial fulfillment of the requirements for the degree of Master of Science in* **HORTICULTURE** *in the Department of* **(Fruit Science)** *has been accepted after evaluation by the External Examiner and approved by the Student's Advisory Committee after an oral examination on the same.*

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Director of Instruction :……..

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Place – Gwalior
Date - *(Rajesh Chouhan)*

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LIST OF SYMBOLS/ABBREVIATIONS

Symbol	Abbreviation	Stands for
/	-	Per
@	-	At the rate of
%	-	Percentage
^{0}C	-	Degree Celsius
-	CD	Critical difference
-	Cm	Centimetre
-	cm^2	Centimeter square
-	cv.	Cultivar
-	DAS	Days After Sowing
-	Df	Degrees of freedom
-	EMSS	Error Mean Sum of Squares
-	*et al.*	et-al (And others)
-	Fig.	Figure
-	G	Gram
	G.P	Germination percentage
-	Ha	Hectare
-	K	Potassium
-	Kg	Kilogram
-	Max.	Maximum
-	Mg	Milligram
-	Min.	Minimum
-	Ml	Millilitre
-	Mm	Millimetre
-	Zn	Zinc Sulphate
-	Mg	Magnisium Sulphate
-	B	Borex
-	m^2	Meter square
-	N	Nitrogen
-	NS	Non-significant
-	P	Phosphorus
	Q	Quintal
	R.H.	Relative humidity
-	RVSKVV	Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya
-	S.Ed.	Standard error of difference
-	S.Em ±	Standard error of mean
	Sq.m	Square meter
-	T	Tonne
	Temp.	Temperature
	MT	Metric Tones
-	var.	Variety
-	*viz.*	Videlicet (Namely)

Chapter - I
INTRODUCTION

Guava (*Psidium guajava* L.), the apple of the tropics, is one of the most popular fruits 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 where as in production after banana, mango, citrus and papaya. India is one of the leading producer of guava in the world. In India guava is cultivated in an area of 262 thousand hectares with production of 3648 thousand MT. Productivity of guava in India is 14 MT per hectare (NHB 2016). The total area and production in M.P. are 24.37 thousand hectares and 912.00 thousand MT with productivity of 37.43 MT per hectare (NHB-2015). In Madhya Pradesh major guava producing areas are Jabalpur, Gwalior, Bhopal Rewa, Neemuch, Ratlam, Khandwa and Mandsaur (Malwa Region).

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 micronutrients. Therefore, there is an urgent need to find out appropriate doses of micronutrients for guava fruit crop to improve the productivity in this zone. The existing variety (G-27) has a great extent. There appears to be a large variation in the yield contributing morphological and physico-chemical parameters. Hence, there is necessity to find out the optimum micronutrient dose based on the performance of morphological, yield attributing and quality characteristics.

The quality of guava fruit is greatly affected by temperature and humidity, because of these facts the fruit quality of winter season is far better than rainy season.

Zinc is the important constituent of several enzyme systems which regulate various metabolic reaction associated with water relation in the plant. Zinc is essential for auxin and protein synthesis, seed production and proper maturity. It also increases fruit size as well as yield. Zinc is essential for improving the vegetative growth of guava trees obtained in terms of terminal

shoots, shoot diameter and number of leaves per shoot. Magnesium is an important nutrient play a vital role in the betterment in both growth and yield attributes may be due to stimulatory effect of Mg on plant metabolism, also, the growth might have been augmented due to higher synthesis of nucleic acids.

Mg also participates in enzymatic activities involved in protein synthesis and cell multiplication. Magnesium is the metallic constituent of chlorophyll. Boron is a constituent of cell membrane and essential for cell division. It acts as a regulator of potassium / calcium ratio in the plant and helps in nitrogen absorption and translocation of sugar in plant.

Boron increases nitrogen availability to plant. It is involved in the synthesis of cell wall components. It has a central role in pollen viability and good fruit set. It increases the elongation growth of primary and lateral roots. Crops notorious for their poor fruit flower ratio will often set more fruit with a pre-bloom boron foliar application.

Hence, keeping the above facts in view, the present investigation entitled **"Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** has been conducted in Department of Horticulture, College of Agriculture, Gwalior (M.P.) with following objectives:

1. To find out the effect of zinc, magnesium and boron on vegetative characters of guava**/**plant.
2. To find out the effect of zinc, magnesium and boron on yield parameters of guava**.**
3. To find out the effect of zinc, magnesium and boron on physio-chemical parameters of guava**.**
4. To work out economics of the 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 foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)”

Chhonkar and Singh (1981) advocated that spray of 0.4 per cent $ZnSO_4$ proved most effective for increasing shoot length, number of leaves and leaf area in both rainy and winter season guava crops. Foliar application of 0.5 or 1.0 per cent zinc at full bloom stage increased fruit set and reduced pre harvest fruit drop.

Mansour and Sied (1981) reported that foliar spray of zinc at 0.5 and 1.0 per cent concentrations increased fruit set, reduced pre-harvest abscission and increased yield; at picking time fruit characters were good. The yield of fruit was also increased from 160-373 fruits/ tree in control to 206-1964 fruits/ tree.

Babu *et al.* (1982) reported that zinc regulated the semi-permeability of cell wall thus mobilizing more water into fruits, thereby increasing the size of fruit.

Singh and Chhonkar (1983) recorded significant increase in total soluble solids, reducing sugar and ascorbic acid content in ‘Mrig-bahar’ guava pulp with foliar spray of 0.4 per cent zinc sulphate solution over control.

Ghosh (1986) reported that foliar application of 0.3% Zn significantly increased the length of fruit, TSS and total sugar while reduced the acidity content in guava fruit.

Ghosh (1985) reported that foliar application of 0.3 per cent zinc in combination with 0.3 per cent Mn and 0.3 per cent Mg significantly increased the weight per fruit, length and diameter of fruit, fruit yield per plant and total soluble solids while decreased the acidity content in guava fruit as compared to alone application of Mg, Zn and Mn including control.

Pandey *et al.* (1988) reported that foliar application of 0.4 per cent $ZnSO_4$ resulted in significant increase in size of fruit, weight per fruit, yield of

fruit per tree, total soluble solids, total sugar while it decreased the acidity content in guava fruit over control.

Sharma *et al.* (1991) reported that foliar application of 0.6 per cent zinc sulphate resulted in significantly highest fruit set (71.96%), fruit weight (165.8 g), number of fruits (498.6/plant), yield (82.39 kg/plant), total soluble solids (11.25%) and ascorbic acid (127.67 mg/100 g) and lowest acidity content in guava fruit (0.36%).

Bagali *et al.* (1993) reported that two spray of zinc sulphate, magnesium sulphate and boron singly and their combinations at 0.3 percent concentration were applied to guava trees cv. Sardar in June and July for winter season crop. Application of secondary and micronutrient elements 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. Among the different treatments foliar application of Zn (99.53kg) and Mg (87.90kg) singly increased the fruit yield per tree significantly.

Dahiya *et al.* (1993) reported that foliar spray of zinc sulphate (0.4%) significantly increased the fruit set, breadth of fruit, weight per fruit, total soluble solids and fruit yield per tree as compared to control.

Sharma and Bhattacharya (1994) observed an increase in vegetative growth due to the foliar spray of Zn.

Wahid *et al.* (1993) sprayed on cv. Allahabad Safeda 2% urea, 1% K_2SO_4, 0.4% $ZnSO_4$, 0.2% borax, 2% urea + 1% K_2SO_4, 2% urea + 0.4% $ZnSO_4$ or 2% urea + 0.2% borax before flowering, at fruit setting and 3 weeks after fruit setting. Untreated plants acted as a control. The treatments had no significant effect on yield but significantly increased fruit weight and breadth compared with the control. Highest fruit weight (84.67 g) and breadth (5.43 cm) were obtained with the 2% urea treatment and this treatment also resulted in highest fruit yield (21.83 kg/tree). All treatments improved fruit quality compared with the control. Highest TSS (11.83%) and total sugar (8.71%) contents and lowest acidity (0.97%) were obtained with 1% K_2SO_4

treatment. Highest cost:benefit ratio (1:9.58) was obtained with 2% urea treatment, followed by 0.2% borax treatment (1:6.35).

Kundu and Mitra (1999) sprayed guava tree with 0.3 percent Zn which produced more fruit set, yield per plant, weight per fruit, diameter of fruit, total soluble solids, total sugar and ascorbic acid and less acidity content over control.

Singh and Brahmachari (1999) assessed the physico-chemical quality of guava fruit under the influence of two levels of zinc (0.5 and 1.0 per cent $ZnSO_4$). The size of fruits (length and breadth), total soluble solids, total sugar and ascorbic acid content of the fruit pulp were enhanced markedly by the application of zinc. Application of 1.0 per cent $ZnSO_4$ resulted in significant reduction in acidity content in guava fruit over 0.5% $ZnSO_4$ and control.

Singh and Brahmachari (1999) conducted an experiment to assess the physicochemical quality of guava fruits under the influence of 3 rates of potassium and 2 rates each of zinc, boron and molybdenum. The size of fruits increased greatly when borax and potassium chloride were sprayed. Fruit quality as evident by TSS and sugar content was enhanced markedly by the application of boron and zinc. The effect of molybdenum was less prominent. The ascorbic acid content of the fruit pulp also increased greatly with the higher concentrations of boron and zinc.

Balakrishnan (2000) assessed the effect of foliar application of micronutrients on vegetative growth, yield and quality of guava. Foliar spray of 1.0 per cent $ZnSO_4$ $7H_2O$ resulted in increase in number of shoots per twig, length of shoot, number of flowers per shoot, fruit set, total soluble solids, ascorbic acid, total sugar and fruit yield per plant over control, but increase in number of flowers per shoot, fruit set, total soluble solids, ascorbic acid and fruit yield was observed significant.

Balakrishnan (2000) studied the foliar applications of Zn as $ZnSO_4$, Fe as $FeSO_4$, Mg as $MgSO_4$ and borax on 6 year old guava cv. Lucknow-49 on the 15 February and 15 April (for the first crop) and on the 15 September and 15 November (for the second crop). 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 and yield of guava compared to the control. The combination of all the micronutrients, Zn at 0.25% + Fe at 0.25% + Mg at 0.25% + borax at 0.1%, resulted in the highest number of shoots per twig (5.97).

Indrayan *et al.* (2000) studied the effect of Zn deficiency on pigment composition, nutrient content and photosynthetic activity in field grown fruit trees and identified Zn deficiency in sweet orange based on the visible symptoms in 15 year old trees in Tamil Nadu. Zinc deficiency affected the chlorophyll contents.

EI-Sherif *et al.* (2000) foliar spray of K2S0 4 (1.0% or 2%) and zinc sulphate (0.5% or 1%) on guava at full bloom stage significantly increased the shoot length, fruit retention, fruit set, yield and quality of fruit. Similarly, foliar spray of Zn at 4g per plant per year significantly increased yield and Zn content of guava leaves.

Lal *et al.,* (2000) A field experiment was conducted in Udaipur, Rajasthan, India, to study the effect on N, Zn and Mn fertilizers in relation to yield and leaf nutrient content of guava. There were 3 levels of N (0, 300 and 600 g N per plant per year, applied as urea), Zn (0, 2 and 4 g Zn per plant per year, applied as $ZnSO_4$) and Mn (0, 2 and 4 g Mn per plant per year, applied as $MnSO_4$) comprising 27 treatment combinations. The full dose of Zn and Mn as foliar spray and half dose of N as basal were applied before flowering and the remaining half dose of N was applied as basal dose at the time of flowering. Application of N at 600 g per plant per year significantly enhanced the fruit yield of guava, and N and Mn content of leaves, while it reduced the P, K and Zn content of leaves. Foliar spray of Zn at 4 g per plant per year significantly increased the yield and Zn content of guava leaves. However, it reduced significantly the Mn content of leaves. Similarly, foliar spray of Mn at 4 g per plant per year significantly increased the fruit yield, N and Zn content of leaves, while it decreased Zn content of guava leaves.

Balakrishnan (2001) studied the influence of foliar application of micronutrients on guava. The foliar spray of 0.5 per cent $ZnSO_4$ significantly

increased the number of flowers per plant, fruit set, fruit yield per tree, total soluble solids and ascorbic acid. The quality character like acidity remained unchanged due to foliar spray of zinc. The foliar spray of 0.5 per cent $ZnSO_4$, although, increased the number of shoots per twig and length of shoot over control but differences were non-significant.

Balakrishnan (2001) studied the effect of foliar sprays of micronutrient on the growth, yield and quality of guava cv. Lucknow-49. The treatments consisted of a control (T1), 0.025 and 0.5% $ZnSO_4$, 0.25 and 0.5% $FeSO_4$, 0.25 and 0.5% $MgSO_4$, 0.1 and 0.2% Borax, alone or in combinations. The foliar sprays of micronutrients were given twice, i.e. at 15 February and 15 April for the first crop and at 15 September and 15 November for the second crop. 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 vegetative growth, yield and fruit quality.

Bhatia *et al.* (2001) reported that guava responded to zinc up to 0.75 per cent concentration in respect of fruit weight and fruit yield per plant.

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 analysed 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.

Lal and Sen (2001) determined the effects of different level of zinc (0, 2 and 4 g/plant) on the fruit quality of guava cv. Allahabad Safeda. The total soluble solids, ascorbic acid, reducing sugar non-reducing sugar, total sugar and pectin content, as well as TSS:acid ratio and pH in fruits linearly increased whereas acidity decreased with increasing rates of Zn.

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 organolaptic 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).

Lal and Sen (2002) reported significant influence of foliar application of zinc (0, 2 and 4 g/plant) on most of the parameters related to flowering, fruiting, yield attributes and yield of guava.

Lal and Sen (2002) reported that combined application of 4 g each Zn and Mn per tree as foliar spray along with soil application of 600g N/tree resulted in significantly highest number of fruits (327/tree) and yield (76.97 kg/tree) over control (no N, Zn and Mn application).

Bhatnagar and Chandra (2003) reported deficiency of manganese and zinc in orchard on the basis of analysis of leaf samples of guava fruit and they observed positive and significant correlation between manganese and zinc.

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. The greatest fruit length (6.521 cm) and width (6.219 cm), fruit weight (139.70 g), pulp/seed ratio (51.370), number of fruits per plant (346.67), yield of fruit (42.75 kg per plant), ascorbic acid content (148.68 mg/100 g pulp) and total sugar content (8.293%) were recorded for the foliar application of 3.0% urea + 1.0% $ZnSO_4$.

Prasad *et al.* (2005) found that 0.8% Borax significantly increased the number of flowers, fruit set, fruit retention, length and diameter of guava cv. Allahbad Safeda. All the treatments increased fruit weight and yield under borax spray followed by spraying 3% urea.

Sarolia *et al.* (2007) involved the foliar application of 0.3, 0.4 and 0.5 percent Zinc sulphate and ferrous sulphate with their possible combination and control trees were sprayed with water alone. Two sprays were given during the month of August and October. It was observed that application of

zinc and iron in the form of zinc sulphate and ferrous sulphate sprays of 0.5 and 0.4 percent concentration; respectively on guava trees were beneficial to obtain promising results.

Yadav *et al.* (2011) investigated the effect of folior application of micronutrients and GA3 on physico-chemical characters and yield of guava fruit cv L-49. the Maximum fruit retention (57.27%) fruit length (6.07cm),fruit width (5.92cm), fruit weight (98.48 kg), fruit yield (48.63 kg per tree). i. e. total soluble solids (11.70 ^{0}Brix), ascorbic acid (172.00 mg /100g), reducing sugar (3.98%), non- reducing (3.53%). Total sugar (7.51%) and minimum fruit drop (42.23%), acidity (0.30%) were recorded with foliar application of borax-0.4per cent followed by zinc sulphate 0.8%.

Wide spread deficiency of micro-nutrients is being reported across the country. The deficiency symptoms are visible in many fruit crops. If is realized that decline in productivity of fruit crops in spite of regular application of macro nutrients might be due to micro nutrient deficiency. This has been indicated by many researchers. Therefore this is high time to conduct field experiment on use of micro nutrients through foliar spray or soil application in order to increase fruit productivity and check degradation of orchards. As micro nutrients status varies with soil, it is interactive to conduct such studies in different fruit growing regions. A comprehensive information on this aspect is missing in Gwalior region. As such with this idea back in mind present investigation was planned at RVSKVV, Gwalior in Department of horticulture this during year 2017-18 on cv G-27.

Chapter – III

MATERIAL AND METHODS

The experiment entitled **"Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** was conducted during 2017-2018 in the Department of Fruit Science, College of Agriculture, Gwalior (M.P.).

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

3.1 Locations

The experiment was conducted on the plant of guava, available at experimental area of the fruit orchard, Department of Horticulture, College of Agriculture, Gwalior in the year 2017-2018.

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 46^0 C in May - June. The winters are cold and minimum temperature reaches as low as 1^0 C in December and January. Frost is expected from the last week of December to first week of February. Usually the monsoon arrives in the second fortnight of June and lasts till September. Drought is a common feature in this region due to scanty and uneven distribution of rainfall. The relevant meteorological data during the crop season are presented in Table 3.1 as well as shown through Fig.1.

Table 1: Weekly meteorological observations during the study period (August-2017 to December-2017)

Week No.	Duration	Average weekly Temperature		Relative Humidity (%)		Weekly Rainfall (mm)
		Max. (^{0}C)	Min. (^{0}C)	Mor.	Eve.	
32	06 Aug- 12 Aug	32.5	26.5	79.6	77.3	92.2
33	13 Aug- 19 Aug	34.7	27.3	78.0	58.0	0
34	20 Aug- 26 Aug	35.7	26.3	86.0	56.7	19
35	27 Aug- 02 Sep	31.1	24.9	91.6	74.7	196.2
36	03 Sep- 09 Sep	34.5	25.5	82.4	56.4	1.6
37	10 Sep- 16 Sep	36.3	26.2	80.3	52.7	0
38	17 Sep- 23 Sep	33.9	24.7	85.6	59.6	72.3
39	24 Sep- 30 Oct	35.5	23.4	81.3	50.6	0
40	01 Oct- 07 Oct	36.1	21.1	86.7	39.7	0
41	08 Oct- 14 Oct	36.7	21.7	82.7	33.6	0
42	15 Oct- 21 Oct	37.1	17.2	83.4	25.7	0
43	22 Oct- 28 Oct	36.5	17.7	75.9	32.3	0
44	29 Oct - 04 Nov	33.4	14.6	86.0	39.0	0
45	05 Nov- 11 Nov	31.3	13.3	93.7	39.3	0
46	12 Nov- 18 Nov	29.8	12.5	90.6	49.3	0
47	19 Nov- 25 Nov	25.6	8.4	85.1	41.1	0
48	26 Nov- 02 Dec	29.1	7.9	90.9	35.0	0
49	03 Dec- 09 Dec	24.9	10.1	87.1	47.3	6
50	10 Dec- 16 Dec	23.7	10.8	92.3	56.1	1
51	17 Dec- 23 Dec	24.0	8.1	78.7	45.1	0
52	24 Dec- 31 Dec	25.1	5.6	96.3	49.0	0

3.3 Experimental materials

Gwalior 27 cultivar of guava (*Psidium guajava* L.) was selected for this study at Department of Fruit Science, College of Agriculture, Gwalior (M.P.).

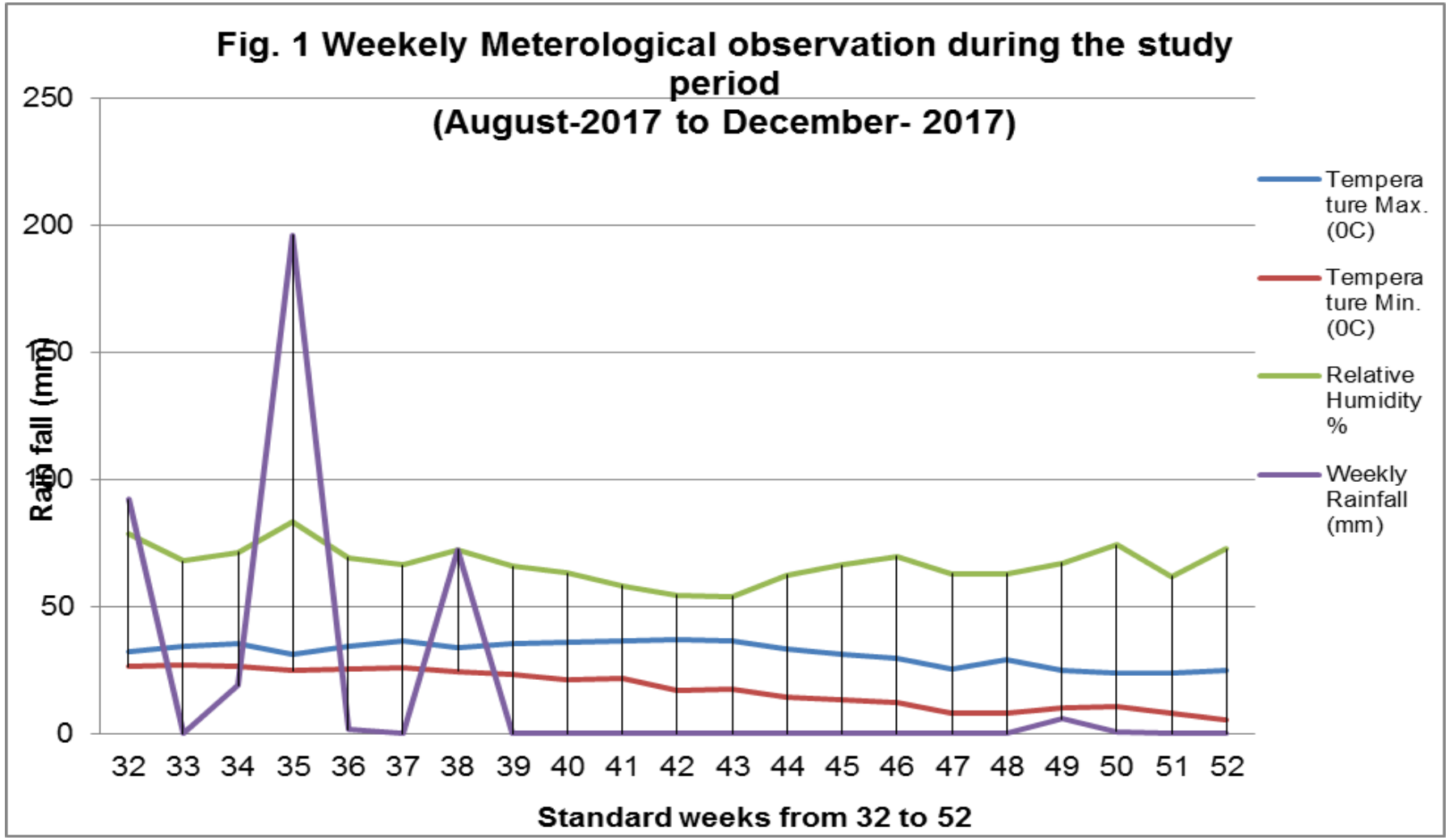


Fig. 1 Weekely Meterological observation during the study period
(August-2017 to December- 2017)
250
200
150
100
50
0
Rain fall (mm)
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52
Standard weeks from 32 to 52
Temperature Max. (0C)
Temperature Min. (0C)
Relative Humidity %
Weekly Rainfall (mm)

3.4 Technical Programme of Work:

Location : Department of Horticulture, College of Agriculture, Gwalior (M.P.) during 2017-18**.**

Experimental details:

Name of the crop and variety	: Guava (*Psidium guajava* L.),G-27
Design	: RBD
No. of treatments	: 07
Number of plants per treatment	: 1
Number of replication	: 3
Plants per replication	: 7
Total no. of plants	: 21
Age of plant	: 16-17 year

Treatments detail:

T_0 – Control

T_1- Zn @ 0.75 %

T_2- Mg @ 0.75%

T_3- B @ 0.40%

T_4- Zn @ 0.75 % + Mg @ 0.75 %

T_5- Zn @ 0.75 % + B @ 0.40 %

T_6- Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%

(Magnesium sulphate (Mg), Zinc Sulphate (Zn)**,** and Borax (**B**))

3.5 Observations recorded

Observations on various morphological characters of plants and physical, chemical parameters of fruits of guava were recorded as per the methods given under different characters.

(A) Vegetative Characters

The growth observations of each plant of the experiment were recorded on the following heads.

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

(B) Reproductive parameters

1. Fruit setting (%)
2. Fruit drop (%)
3. Fruit retention (%)

(C) Physical parameters:

1. Size of fruit (cm)
    a. Fruit length (cm)
    b. Fruit width (cm)
2. Pulp thickness (cm)
3. Fruit volume (cc)
4. Specific gravity
5. Pulp weight (g)
6. Seed weight (g)
7. Seed /pulp ratio
8. Pulp per cent
9. Seed per cent

(D) Chemical parameters of fruits:

1. TSS (^{0}Brix)
2. Acidity (%)

(E) Yield parameters:

1. No. of fruit per tree
2. Average fruit weight (g)
3. Fruit yield (kg/ tree)
4. Fruit yield (q/ ha)

(A) Vegetative Characters

Shoot length (cm)

Five newly emerged 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 increasing length of shoot was calculated on the basis of initial length of shoot on each day of observation.

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 diameter of shoot.

Number of leaves per shoot

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

(B) Reproductive parameters

Fruit setting (%)

Four branches are randomly selected and tagged on the plant and the number of flowers counted separately on each branch after that number of fruits counted. The fruit setting per cent is calculated with following formula:

Fruit setting (%) = (Number of set fruits/ Number of flowers) x100

Fruit drop (%)

The fruit drop percent is calculated with following formula:

Fruit drop (%) = fruit setting (%) – fruit retention (%)

Fruit retention (%)

Four branches which are selected for fruit setting, number of fruits at harvest are counted on them. The fruit retention per cent is calculated with following formula:

Fruit retention (%) = (Number of fruits at harvest/ Number of flowers) x 100

(B) Physical parameters

Four ripe fruits from each selected trees were collected for recording various physical parameters.

Size of fruit

(a) Fruit length (cm)

The length of fruits was measured from stem end to calyx end in centimeters, after cutting the fruits in two equal pieces, with the help of vernier calipers.

(b) Fruit width (cm)

The width of the fruits was measured from the centre of cut pieces of the fruits in centimeters with the help of vernier calipers.

Pulp thickness (cm)

The pulp thickness of fruits was measured from inner layer of fruits to outer layer of seed in centimeters, after cutting the fruit in two equal pieces with the help of vernier calipers.

Fruit volume (ml)

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

Specific gravity

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

Pulp weight (g)

Extraction of fruit pulp was done by crushing the fruit and removal of seeds and total weight of pulp was calculated.

Seed weight (g)

Extraction of seeds was done by crushing the fruit and washing the seeds in water and total weight of seed was calculated.

Seed /pulp ratio

The weight of the seeds and the pulp of fruit were taken separately and their weights were expressed in ratio.

Pulp per cent

The weight of pulp was calculated by dividing the weight of seed from the total weight of fruit. Pulp percentage was calculated by using the following.

$$\text{Pulp percentage} = \frac{\text{Total weight of pulp}}{\text{Total weight of fruit}} \times 100$$

Seed per cent

Extraction of seeds was done by crushing the fruit and washing the seeds in water. The seed weight was recorded in gram with the help of physical balance. The percentage of seed weight was calculated by the following formula.

$$\text{Seed percentage} = \frac{\text{Average weight of Seed per fruit}}{\text{Average weight of fruit}} \times 100$$

(D) Chemical parameters of fruits:

TSS (^{0}Brix)

All the fruits of each plant were crushed to form a homogenized sample and then the juice was extracted through muslin cloth. The extract was used for determination of T.S.S. in ^{O}Brix by hand refractometer. Few drops of juice were placed on the surface of prism. The hinged part was placed back. The refractometer was then placed against the sun the reading was noted by revolving the eyepiece at room temperature (A.O.A.C., 1970)

Acidity (%)

Acidity was estimated by simple acid–alkali titration method as described in A.O.A.C. in (1970). 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.

Total acidity per cent = 0.128 × titer value

(E) Yield parameters:

No. of fruit per tree

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

Average fruit weight (g)

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

Average Fruit Weight (g) = Total weight of fruits (g)/ Number of fruits

Fruit yield (kg/ tree)

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

Yield per hectare (Quintal)

The yield per hectare were calculated in quintal per hectare by calculating total number of plants per hectare and multiplied with average yield per tree.

3.6 Statistical analysis:

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

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

$$\text{(a) S.Em.} \pm \text{ for T} = \sqrt{\frac{EMS}{R}}$$

3.6.2 Critical difference (CD):

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

Where:-

R	=	Number of Replications
T	=	Treatments
t	=	't' Table value at error degree of freedom
EMS	=	Error mean sum of square
S. Em.	=	Standard error of mean
CD	=	Critical difference

Table 2: Skeleton of analysis of variance

Sources of Variation	Degree of Freedom	Sum of Squares	Mean Sum of Squares	'F' value (calculated)	'F' value (table) at 5% level of significance
Replication	2	RSS	RMS	RMS/EMS	
Treatment	6	TSS	TMS	TMS/EMS	
Error	12	ESS	EMS		
Total	20				

Chapter - IV
RESULTS

An investigation entitled "**Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** was carried out at the Department of Horticulture, College of Agriculture, Gwalior (M.P.) during 2017-18**.**

The observations recorded on vegetative Characters, reproductive parameters, physical parameters, chemical parameters of fruits and yield parameters of guava under this study are given in table 3 to 8 and in Fig. 2 to 23. The Analysis of Variance for these characters is given in Appendices. The economics of the different treatments are given in table 9.

4.1 Vegetative Characters:

The observations regarding the effect of micronutrient spray on the morphological characters, *viz*. shoot length, shoot diameter (cm) and number of leaves per shoot are given in table 3, Fig. 2 to 4 and the analysis of variance for these characters are given in Appendixs I.

4.1.1 Shoot length (cm)

Data presented in table 3 & fig 2 revealed that the shoot length was significantly affected by the foliar application of Magnesium sulphate, Zinc sulphate and Borax over the control. The mean maximum shoot length (13.85 cm) was recorded under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was followed by the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %), (12.98 cm), while minimum shoot length (9.08 cm) was recorded under control (T_0). Also give which treatment showed significant variations.

4.1.2 Shoot diameter (mm)

Data presented in table 3 & fig 3 revealed that the shoot diameter was significantly affected by the foliar application of Magnesium sulphate, Zinc sulphate and Borax over the control. The mean maximum shoot diameter (0.53 mm) was recorded under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which

was followed by the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) and treatment T_4 (Zn @ 0.75 % +Mg @ 0.75 %), (0.49 and 0.48 mm), while minimum shoot diameter (0.31 mm) was recorded under control (T_0).

4.1.3 Number of leaves per shoot

Data presented in table 3 & fig 4 revealed non-significantly effect on number of leaves per shoot by the foliar application of Magnesium sulphate, Zinc sulphate and Borax over the control.

Table 3: Effect of foliar spray of zinc, magnesium and boron on vegetative characters of guava

Treatment	Shoot length (cm)	Shoot diameter (cm)	No of leaf per shoot
T_0	9.08	0.31	10.32
T_1	11.53	0.40	11.23
T_2	12.02	0.42	11.44
T_3	12.67	0.42	11.46
T_4	12.90	0.48	11.51
T_5	12.98	0.49	11.65
T_6	13.85	0.53	11.65
S.Em.±	**0.0124**	**0.0041**	**0.3296**
CD at 5%	**0.0381**	**0.0126**	**NS**

4.2 Reproductive Parameters:

The observations regarding the effect of foliar application of Magnesium sulphate, Zinc sulphate and Borax, on the reproductive characters *viz*., fruit setting, fruit drop and fruit retention percentage are given in tables 4 and the analysis of variance for these characters is in Appendix II.

4.2.1 Fruit setting (%)

The fruit setting percentage significantly influenced by the foliar application of Magnesium sulphate, Zinc sulphate and Borax. (Table 4, Fig.5). Consequently the maximum (74.77 %) fruit setting percentage was observed under the treatment of T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), followed by (71.00 %) under the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %), whereas the minimum fruit setting (54.21%) percentage was noticed under T_0 (Control). Also give significant & non significant variations in this section.

4.2.2 Fruit drop (%):

The data presented in Table 4 and Fig. 6 reveal that the fruit drop percentage was significantly influenced by the application of Magnesium sulphate, Zinc sulphate and Borax. The minimum fruit drop percentage (19.40 %) was found under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and maximum (24.98 %) in T_0 (control).

4.2.3 Fruit retention (%):

The fruit retention percentage was significantly influenced by application of the application of Magnesium sulphate, Zinc sulphate and Borax. Data presented in Table 4 and Fig. 7 show that the maximum fruit retention (55.37 %) was found in treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and minimum (29.23 %) under treatment T_0 (control).

Table 4: Effect of foliar spray of zinc, magnesium and boron on reproductive parameters of guava

Treatment	Fruit setting (%)	Fruit drop %	Fruit retention %
T_0	54.21	24.98	29.23
T_1	57.13	23.81	31.89
T_2	60.32	22.69	33.32
T_3	68.27	21.53	36.50
T_4	70.28	20.89	49.60
T_5	71.00	20.36	51.60
T_6	74.77	19.40	55.37
S.Em.±	**0.2295**	**0.0572**	**0.3103**
CD at 5%	**0.7072**	**0.1761**	**0.9562**

4.3 Physical parameters:

The data on the effect of Magnesium sulphate, Zinc sulphate and Borax on physical parameters of the fruit *viz.*, size of fruits (length and width), pulp thickness, fruit volume, specific gravity, pulp weight, seed weight (g), seed/ pulp ratio, pulp per cent and seed per cent percentage are given in Table 5 to 6 and Fig. 8 to 17. The analysis of variance for the same is given in Appendices III.

4.3.1 Size of fruit (cm)

4.3.1.1 Fruit length (cm):

Data presented in Table 5 and Fig. 8 revealed that fruit length at harvest was significantly influenced by application of Magnesium sulphate, Zinc sulphate and Borax. The maximum fruit length (6.61 cm) at harvest was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with T_5

(6.53 cm) (Zn @ 0.75 % + B @ 0.40 %), whereas minimum fruit length (5.34 cm) was recorded under T_0 (Control).

4.3.1.2 Fruit diameter (cm):

Data presented in Table 5 and Fig. 9, revealed that fruit diameter at harvest was significantly influenced by the application of Magnesium sulphate, Zinc sulphate and Borax. The maximum fruit diameter (6.69 cm) at harvest was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by T_5 (6.39 cm) (Zn @ 0.75 % + B @ 0.40 %), which were superior to all other treatments and minimum fruit diameter was (6.16 cm) in T_0 (control).

Table 5: Effect of foliar spray of zinc, magnesium and boron on physical parameters of guava

Treatment	Size of fruit (cm)		Pulp thickness	Fruit volume (ml)	Specific gravity
	Fruit length (cm)	Fruit width (cm)			
T_0	5.34	6.16	2.07	130.44	1.05
T_1	6.26	6.21	2.46	136.76	1.05
T_2	6.33	6.31	2.75	139.02	1.05
T_3	6.39	6.36	2.95	143.07	1.05
T_4	6.42	6.39	3.06	145.02	1.05
T_5	6.53	6.39	3.19	152.07	1.05
T_6	6.61	6.69	3.44	154.21	1.05
S.Em.±	**0.0240**	**0.0013**	**0.0205**	**3.3531**	**0.0014**
CD at 5%	**0.0740**	**0.0039**	**0.0633**	**10.3320**	**NS**

4.3.2 Pulp thickness (cm)

The pulp thickness of fruit was significantly influenced by the application of Magnesium sulphate, Zinc sulphate and Borax, (Table 5 and Fig. 10). The maximum pulp thickness (3.44 cm) was found by the application of treatment T_6 (Zn @ 0.75 %

+ Mg @ 0.75%+ B @ 0.40%) followed by T_5 (Zn @ 0.75 % + B @ 0.40 %) (3.19 cm) and minimum pulp thickness was found (2.07 cm) under T_0 (control).

4.3.3 Fruit volume (ml)

The data pertaining to fruit volume presented in Table 5 and Fig. 11 revealed that various treatments had significant influence on fruit volume. The maximum fruit volume (154.21 ml) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (152.07 ml) and T_4- Zn @ 0.75 % +Mg @ 0.75 % (145.02 ml) and minimum (130.44 ml) under control (T_0).

4.3.4 Specific gravity

Data regarding specific gravity of fruit presented in Table 5 and Fig. 12 revealed that various treatments had non-significant influence on specific gravity of guava fruit.

4.3.5 Pulp weight (g)

The pulp weight of fruit was significantly influenced by the application of Magnesium sulphate, Zinc sulphate and Borax (Table 6 and Fig. 13). The maximum pulp weight (155.56 g) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (144.37 g ml) and minimum (131.66 g) under T_0 (control).

4.3.6 Seed weight (g)

The seed weight was non-significantly influenced by the application of all the treatments (Table 6 and Fig. 14).

4.3.7 Seed:Pulp ratio

The seed/pulp ratio of fruit was significantly influenced by the application of Magnesium sulphate, Zinc sulphate and Borax (Table 6 and Fig. 15). The maximum seed:pulp ratio (27.95) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (25.71) and minimum (23.29) at T_0 (control).

4.3.8 Pulp per cent

Data presented in Table 6 and Fig. 16 revealed that pulp percentage was significantly influenced by application of Magnesium sulphate, Zinc sulphate and Borax. The maximum pulp percentage (96.50 %) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (96.42 %) and minimum pulp per cent (95.82 %) under T_0 (Control).

4.3.9 Seed per cent

Data presented in Table 6 and Fig. 17 revealed that seed percentage was significantly influenced by application of Magnesium sulphate, Zinc sulphate and Borax. The minimum seed percentage (4.13 %) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (4.21 %) and maximum seed per cent (4.92 %) under T_0 (Control).

Table 6: Effect of foliar spray of zinc, magnesium and boron on physical parameters of guava

Treatments	Pulp weight (g)	Seed weight (g)	Seed :Pulp Ratio	Pulp (%)	Seed (%)
T_0	131.66	5.78	23.29	95.82	4.92
T_1	138.01	5.77	24.34	96.00	4.65
T_2	146.32	5.75	25.98	96.05	4.64
T_3	153.38	5.70	27.36	96.20	4.46
T_4	140.25	5.70	24.66	96.26	4.27
T_5	144.37	5.69	25.71	96.42	4.21
T_6	155.56	5.65	27.95	96.50	4.13
S.Em.±	**3.2747**	**0.1091**	**0.4439**	**0.0597**	**0.0082**
CD at 5%	**10.0903**	**NS**	**1.3679**	**0.1840**	**0.0254**

4.4 Chemical parameters of fruits:

The effects of Magnesium sulphate, Zinc sulphate and Borax on the chemical parameters of guava are given in Tables 7 and diagrammatically represent in Fig. 18 to 19. The analysis of variance for the same is given in the Appendix IV.

The observations on the chemical characteristics *viz.* total soluble solids (TSS) and acidity in fruits was found at the harvest and the data are given below:

4.4.1 TSS (^{0}Brix)

The application of Magnesium sulphate, Zinc sulphate and Borax significantly influenced the total soluble solids content of fruits as compared to control (Table 7 and Fig. 18). The maximum total soluble solids (10.27 ^{0}Brix) was found in T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and minimum (8.50 ^{0}Brix) under T_0 (control).

4.4.2 Acidity (%)

The application of Magnesium sulphate, Zinc sulphate and Borax was shown non-significantly influenced the acidity (Table 7 and Fig. 19).

Table 7: Effect of foliar spray of zinc, magnesium and boron on chemical parameters of guava

Treatment	TSS (%)	Acidity (%)
T_0	8.50	0.68
T_1	9.91	0.68
T_2	9.92	0.69
T_3	10.08	0.69
T_4	10.11	0.70
T_5	10.12	0.70
T_6	10.27	0.71
S.Em.±	**0.2182**	**0.0113**
CD at 5%	**0.6724**	**NS**

4.5 Yield parameters:

The application of Magnesium sulphate, Zinc sulphate and Borax affects the yield parameters are given in tables 8 and fig. 20 to 23. The analysis of variance for the same is given in the Appendix V.

4.5.1 No. of fruit per tree

The data presented in Table 8 and Fig. 20 shows that number of fruits per tree was significantly influenced by application of Magnesium sulphate, Zinc sulphate and Borax. The maximum (152) number of fruits per tree was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5, T_4 and T_3 (151, 148 and 145) and minimum (139) number of fruits per tree was in T_0 (Control) respectively.

4.5.2 Average fruit weight (g)

The data presented in Table 8 and Fig. 21 revealed that Magnesium sulphate, Zinc sulphate and Borax application significantly influenced the average fruit weight. The maximum fruit weight (161.21 g) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5, T_4 and T_3 (159.07, 152.02 and 150.07) and minimum (137.44) weight of fruits was in treatment T_0 (Control) respectively.

4.5.3 Yield per plant (kg/ tree)

Data regarding fruit yield per tree presented in Table 8 and Fig. 22 revealed that fruit yield per tree was significantly influenced by foliar application of Magnesium sulphate, Zinc sulphate and Borax. The maximum fruit yield per tree (24.50 kg/tree) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5 (Zn @ 0.75 % + B @ 0.40 %) (24.02 kg/tree), and minimum fruit yield (19.06 kg/tree) was recorded in treatment T_0 (control).

Table 8: Effect of foliar spray of zinc, magnesium and boron on yield parameters of guava

Treatment	Number of fruit per plant	Average fruit weight (g)	yield per plant (kg)	Yield per hac (q)
T_0	139	137.44	19.06	52.99
T_1	140	143.76	20.44	56.83
T_2	143	146.02	20.57	57.18
T_3	145	150.07	21.76	60.50
T_4	148	152.02	22.50	62.54
T_5	151	159.07	24.02	66.77
T_6	152	161.21	24.50	68.12
S.Em.±	2.4119	3.3531	0.4673	1.2990
CD at 5%	7.4319	10.3320	1.4398	4.0027

4.5.4 Yield per ha (q):

Data regarding fruit yield per ha presented in Table 8 and Fig. 23 revealed that fruit yield per ha was significantly influenced by foliar application of Magnesium sulphate, Zinc sulphate and Borax. The maximum fruit yield per ha (68.12 q/ha) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5 (Zn @ 0.75 % + B @ 0.40 %) (66.67 q/ha), and minimum fruit yield (52.99 q/ha) was recorded in treatment T_0 (control).

4.6 Economics of the different treatments:

A critical examination of data presented in Table 9 revealed that various treatments increased the net returns and B:C ratio. Maximum net returns (Rs 63347.11/ha) was recorded in T_5 (Zn @ 0.75 % + B @ 0.40 %) and minimum (Rs 48892.10/ha) in control. Whereas, maximum B:C ratio (2.71:1) was reported with T_3 (B @ 0.40%) while minimum (2.32:1) in T_1.

Table 9: Economics of the different treatments.

Treatments	Treatment cost/ha	Common expenditure	Total expenditure/ha	Total yield/ha	Price/q	Gross income/ha	Net income/ha	B:C ratio
T_0	0.00	20000	20000.00	52.99	1300	68892.10	48892.10	2.44
T_1	2250.00	20000	22250.00	56.83	1300	73880.30	51630.30	2.32
T_2	2250.00	20000	22250.00	57.18	1300	74331.04	52081.04	2.34
T_3	1200.00	20000	21200.00	60.50	1300	78643.62	57443.62	2.71
T_4	4275.00	20000	24275.00	62.54	1300	81301.63	57026.63	2.35
T_5	3450.00	20000	23450.00	66.77	1300	86797.11	63347.11	2.70
T_6	5475.00	20000	25475.00	68.12	1300	88559.60	63084.60	2.48

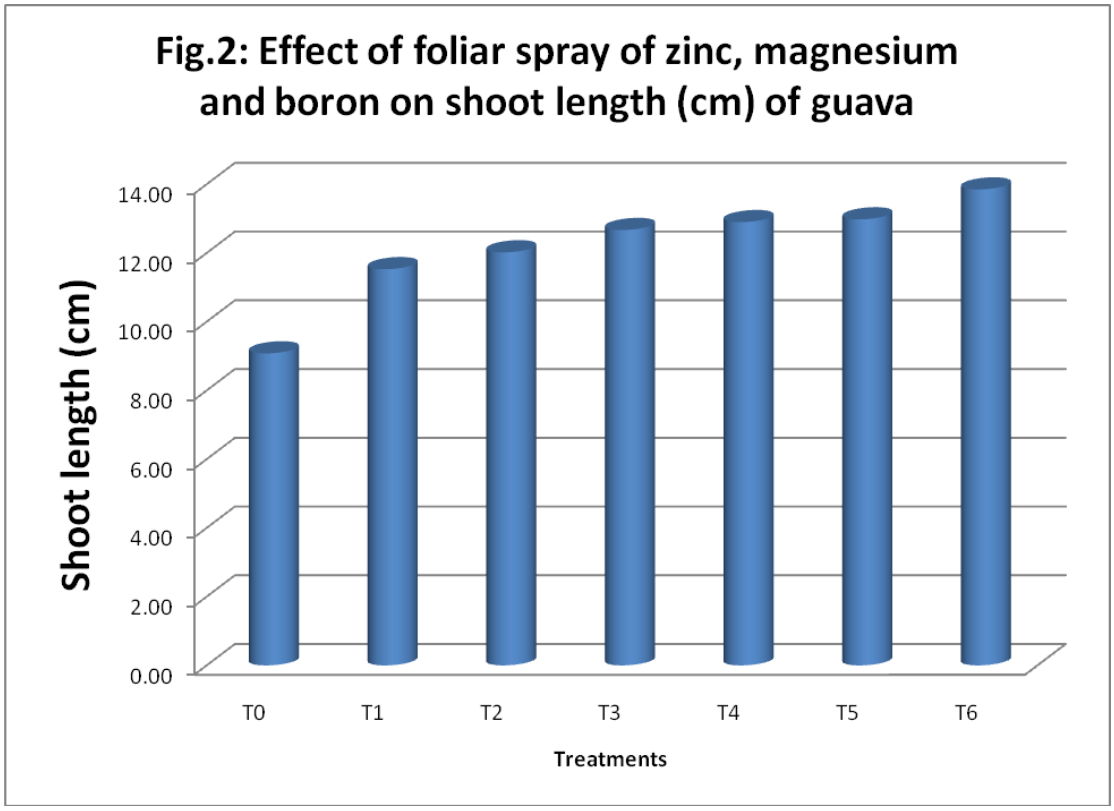


Fig.2: Effect of foliar spray of zinc, magnesium and boron on shoot length (cm) of guava
Shoot length (cm)
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
T0
T1
T2
T3
T4
T5
T6
Treatments

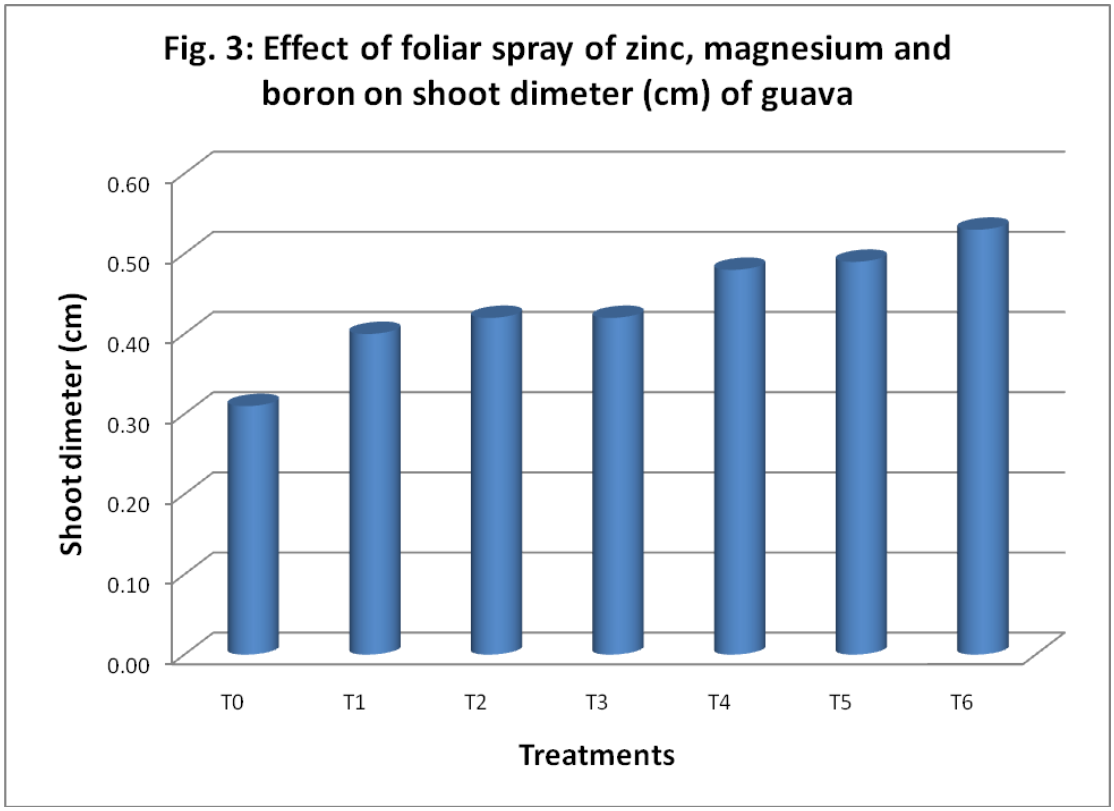


Fig. 3: Effect of foliar spray of zinc, magnesium and boron on shoot dimeter (cm) of guava
Shoot dimeter (cm)
0.60
0.50
0.40
0.30
0.20
0.10
0.00
T0
T1
T2
T3
T4
T5
T6
Treatments

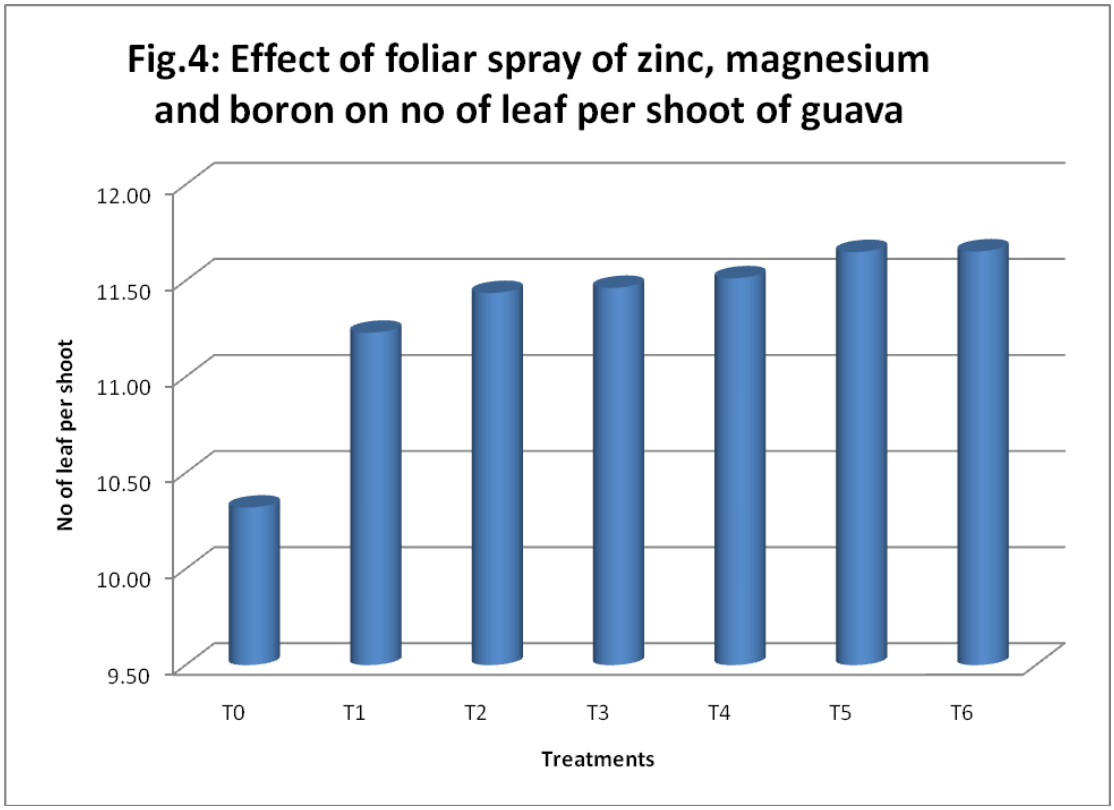


Fig.4: Effect of foliar spray of zinc, magnesium and boron on no of leaf per shoot of guava
12.00
11.50
11.00
10.50
10.00
9.50
No of leaf per shoot
T0
T1
T2
T3
T4
T5
T6
Treatments

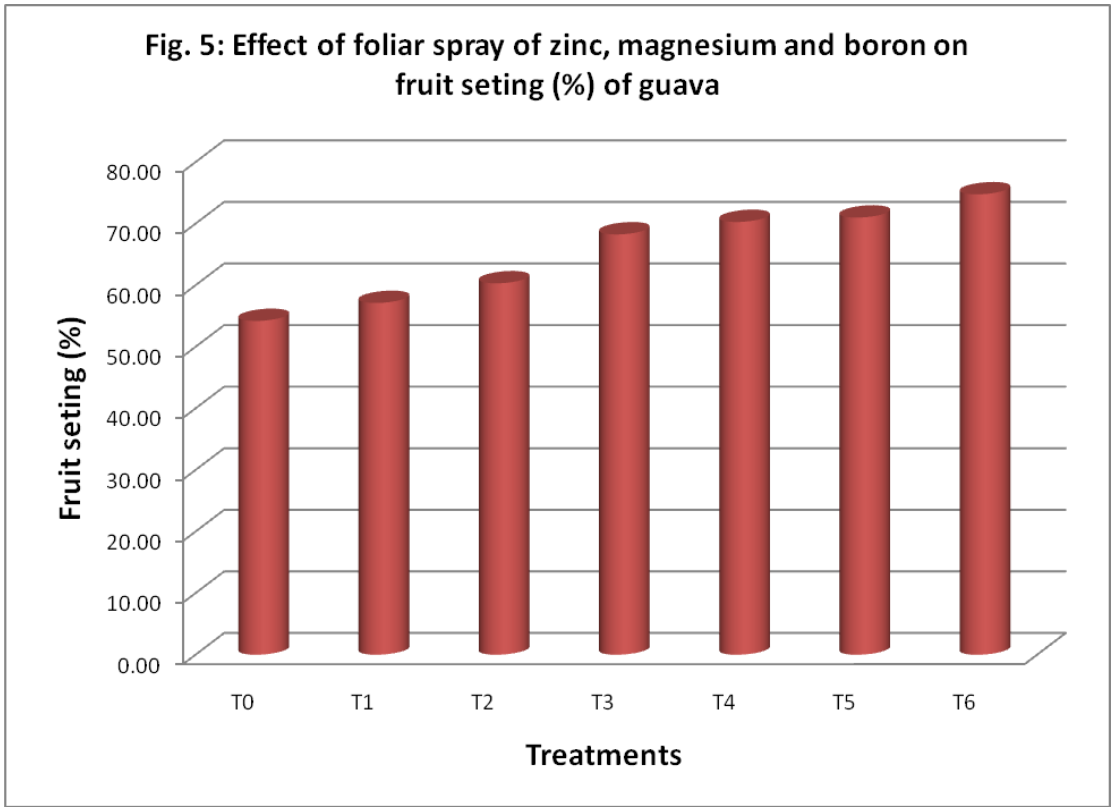


Fig. 5: Effect of foliar spray of zinc, magnesium and boron on fruit seting (%) of guava
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Fruit seting (%)
T0
T1
T2
T3
T4
T5
T6
Treatments

Fig. 6: Effect of foliar spray of zinc, magnesium and boron on fruit retention % of guava

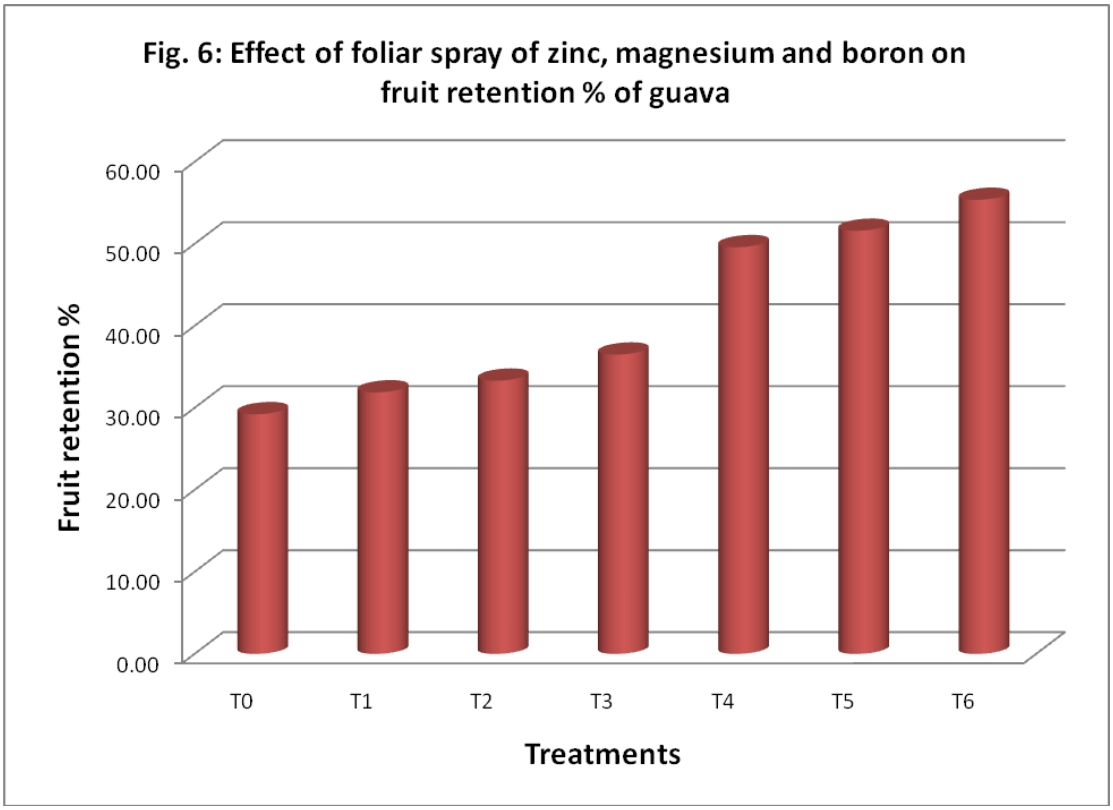


Fig. 7: Effect of foliar spray of zinc, magnesium and boron on fruit drop % of guava

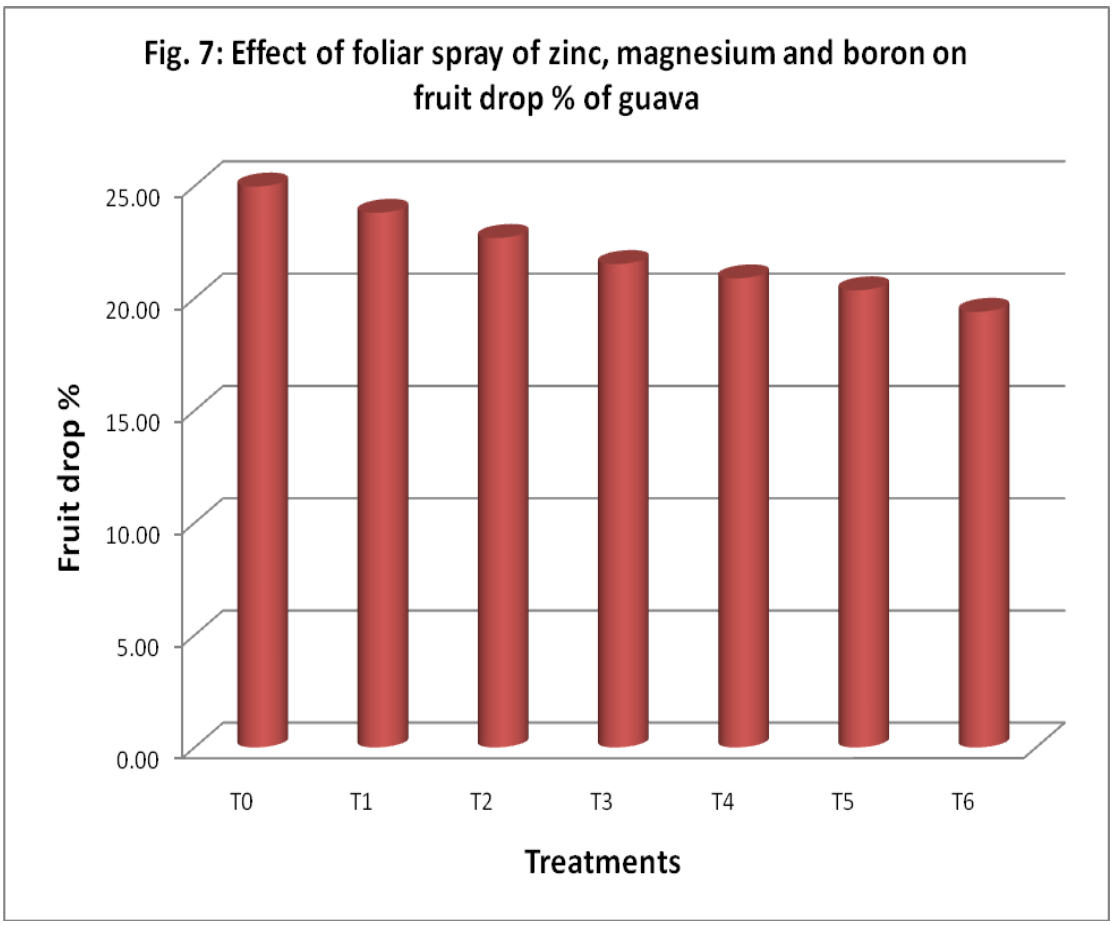


Fig. 8: Effect of foliar spray of zinc, magnesium and boron on fruit length (cm)of guava

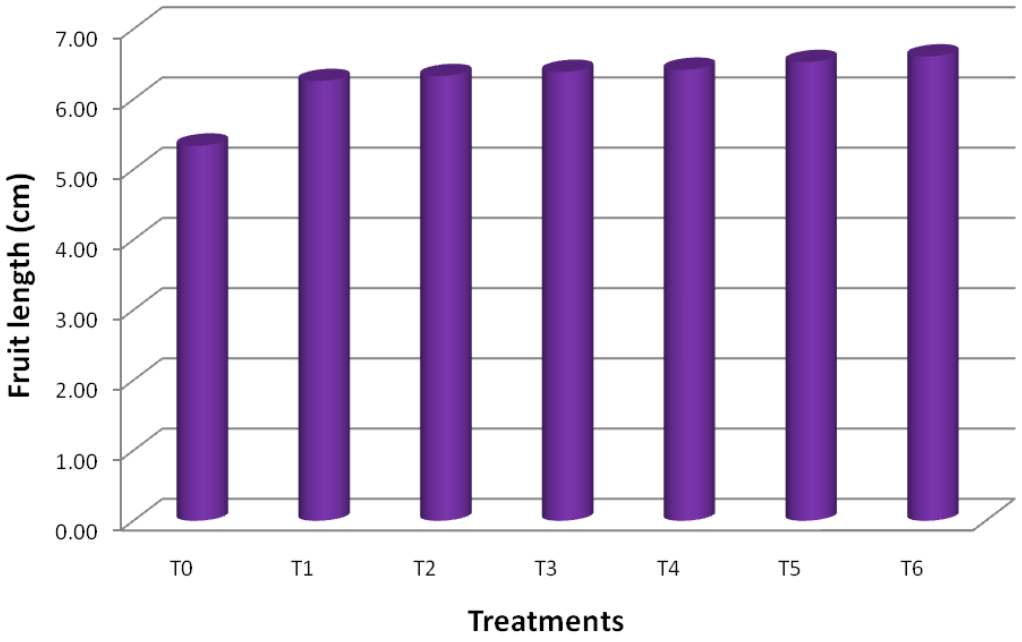


Fig. 9: Effect of foliar spray of zinc, magnesium and boron on fruit width (cm) of guava

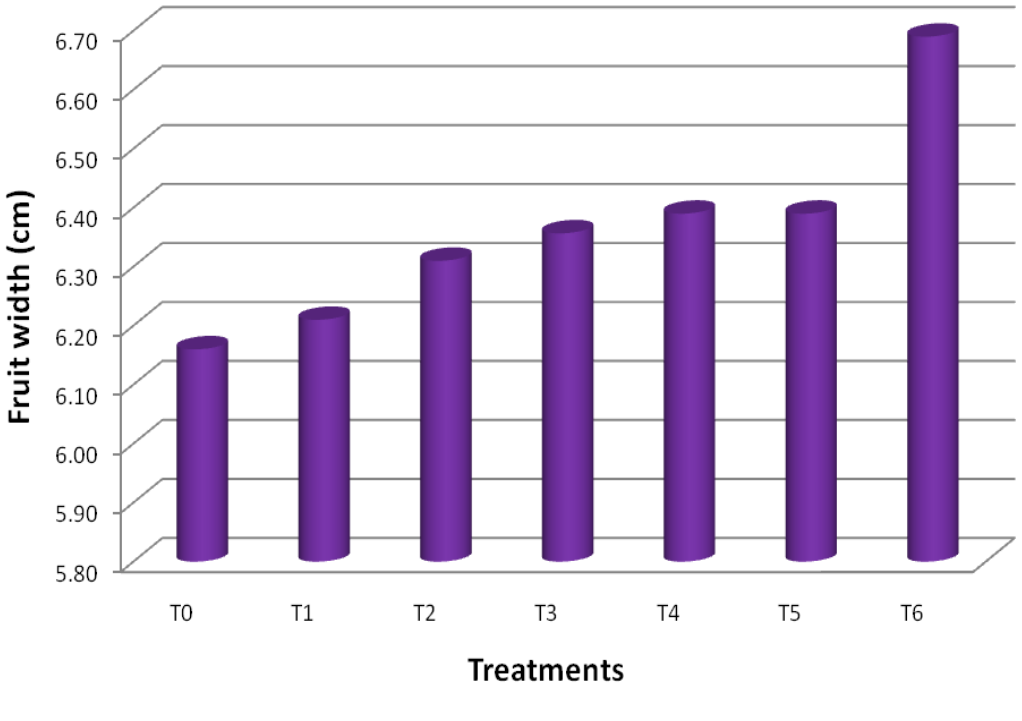


Fig. 10: Effect of foliar spray of zinc, magnesium and boron on pulp thickness (cm) of guava

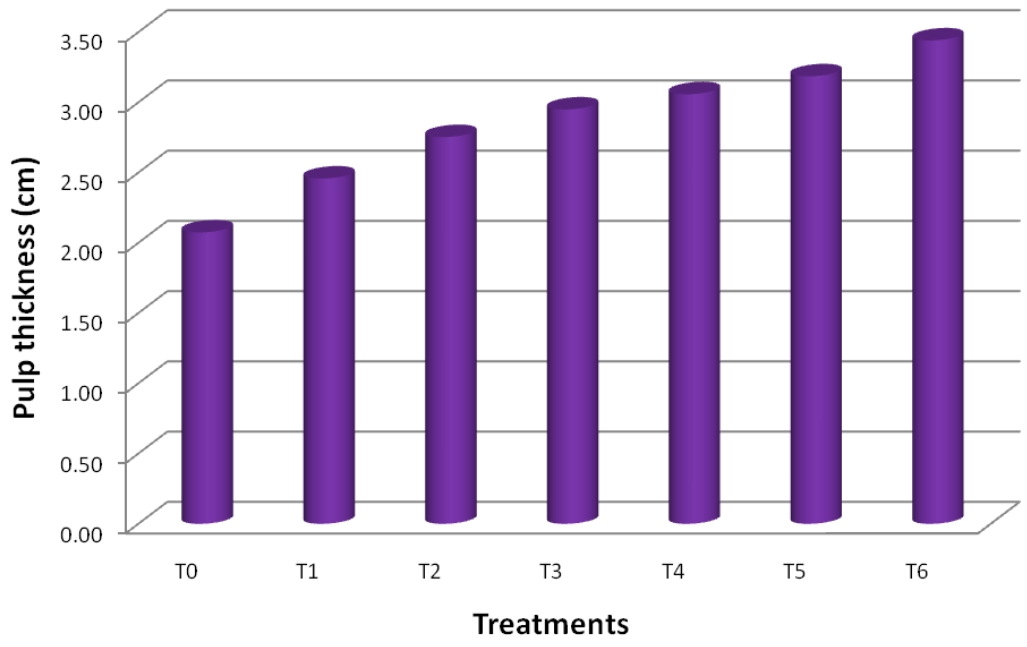


Fig. 11: Effect of foliar spray of zinc, magnesium and boron on fruit volume (ml) of guava

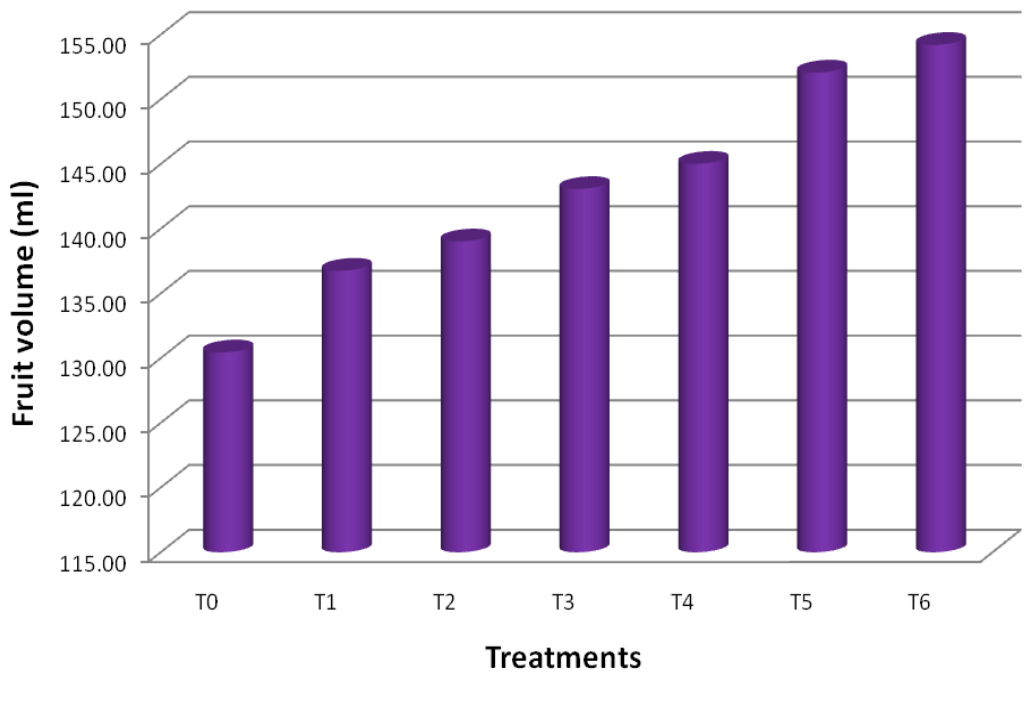


Fig. 12: Effect of foliar spray of zinc, magnesium and boron on specific gravity of guava

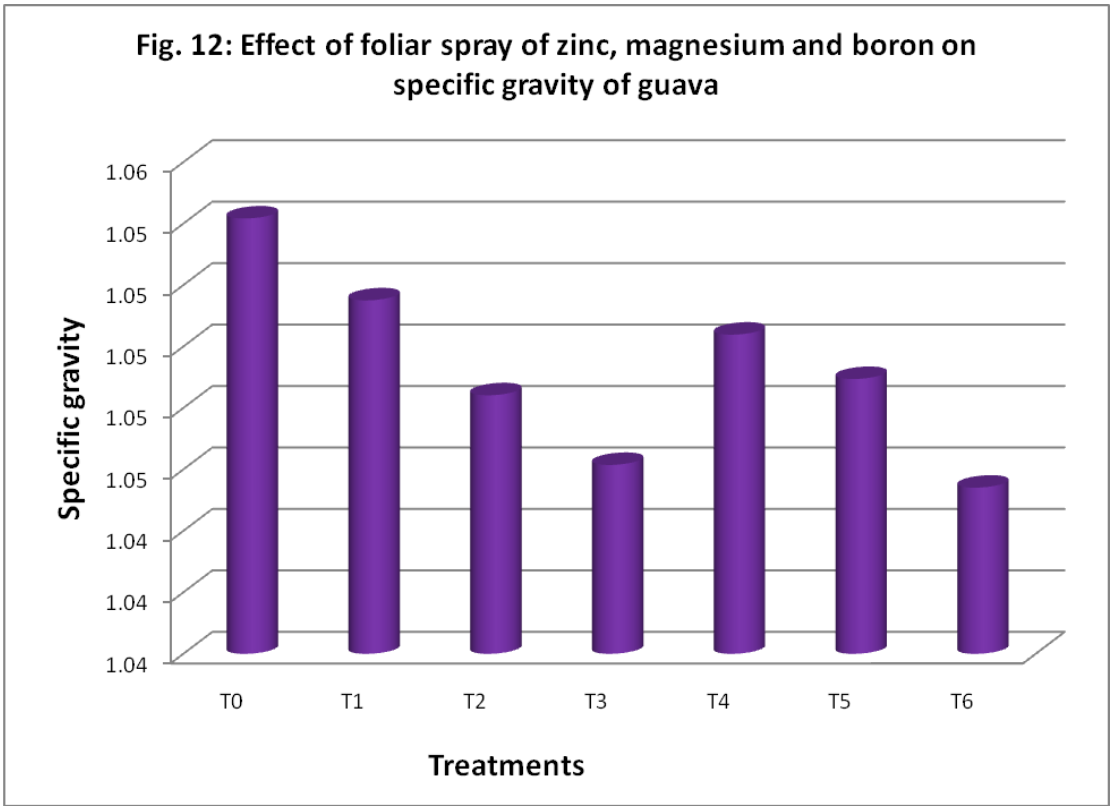
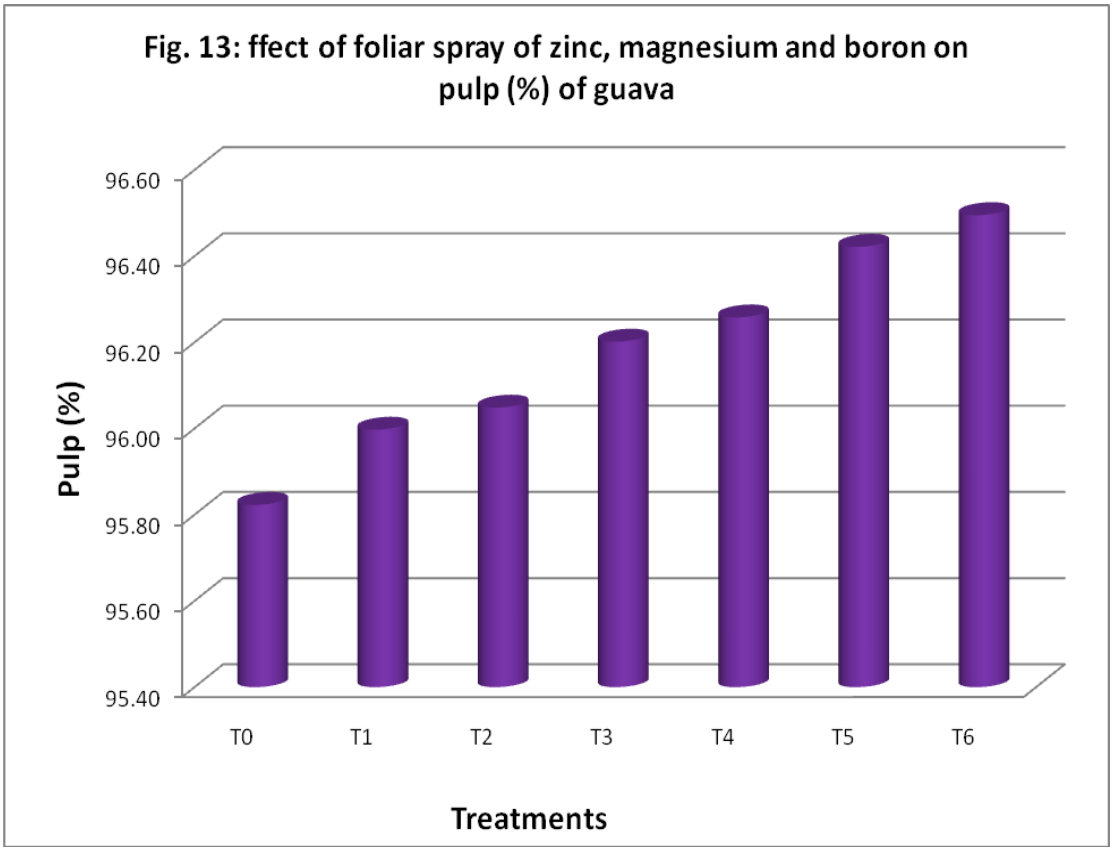


Fig. 13: ffect of foliar spray of zinc, magnesium and boron on pulp (%) of guava



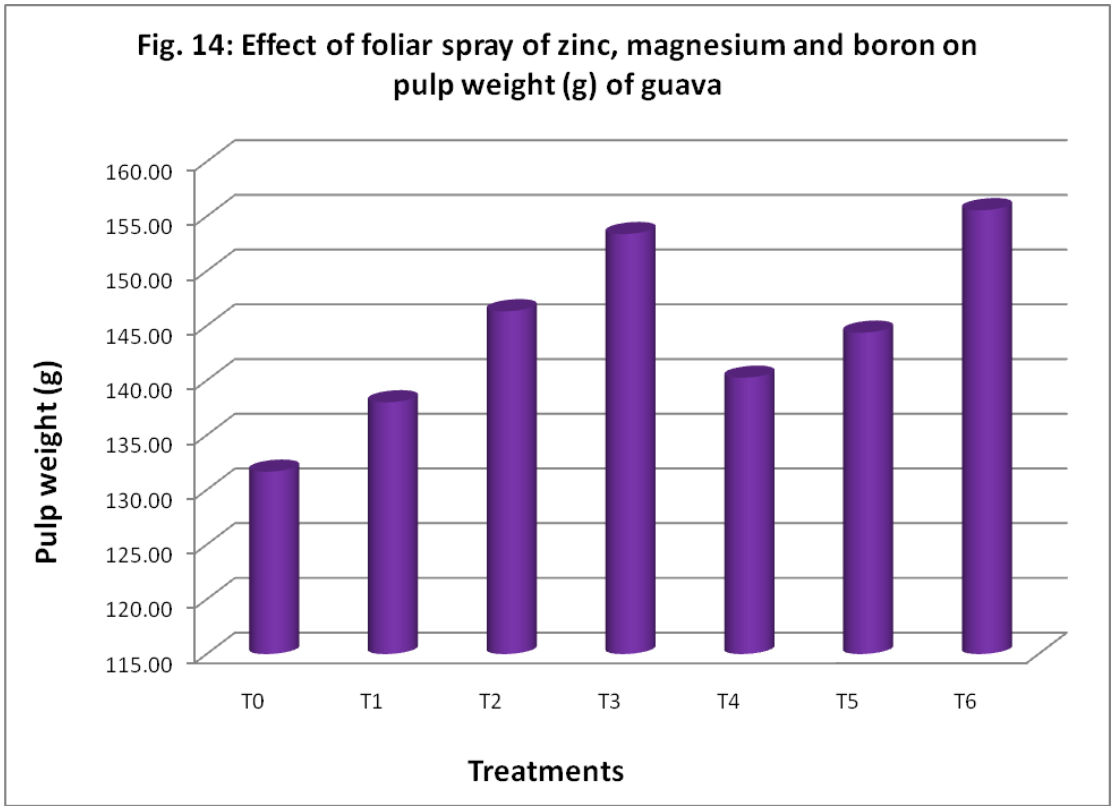


Fig. 14: Effect of foliar spray of zinc, magnesium and boron on pulp weight (g) of guava
Pulp weight (g)
160.00
155.00
150.00
145.00
140.00
135.00
130.00
125.00
120.00
115.00
T0
T1
T2
T3
T4
T5
T6
Treatments

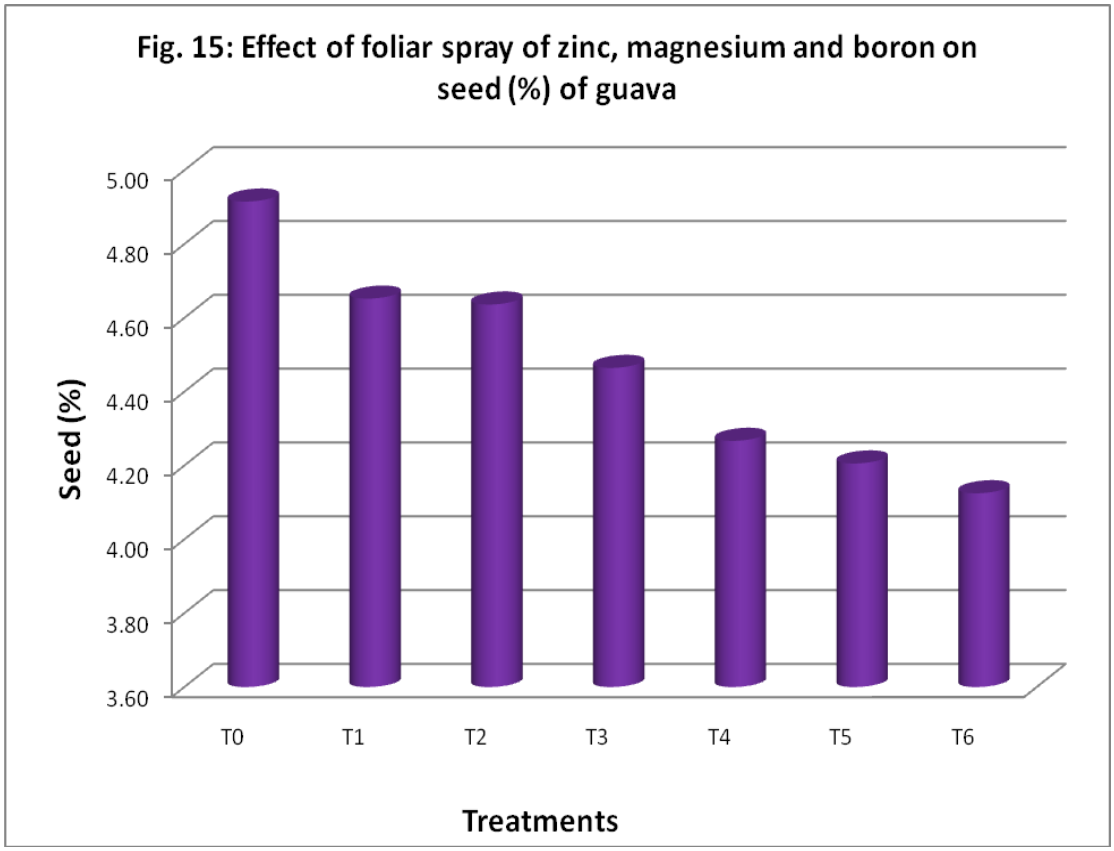


Fig. 15: Effect of foliar spray of zinc, magnesium and boron on seed (%) of guava
Seed (%)
5.00
4.80
4.60
4.40
4.20
4.00
3.80
3.60
T0
T1
T2
T3
T4
T5
T6
Treatments

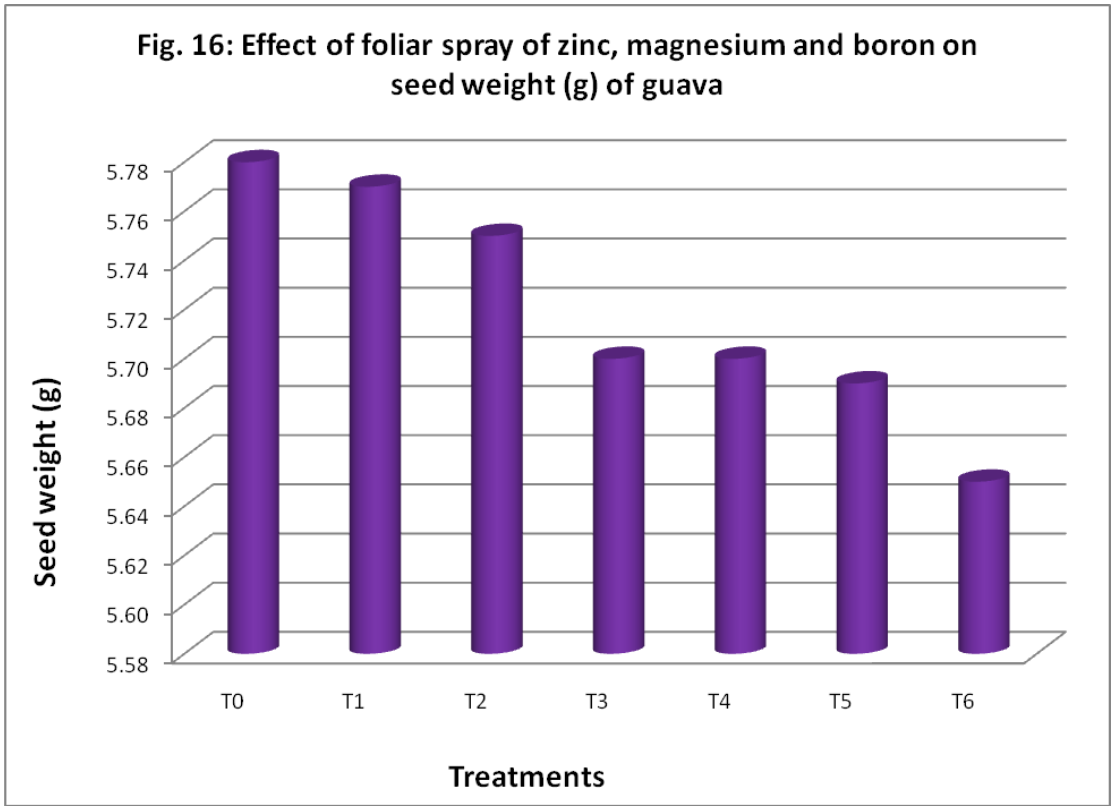


Fig. 16: Effect of foliar spray of zinc, magnesium and boron on seed weight (g) of guava
Seed weight (g)
5.78
5.76
5.74
5.72
5.70
5.68
5.66
5.64
5.62
5.60
5.58
T0
T1
T2
T3
T4
T5
T6
Treatments

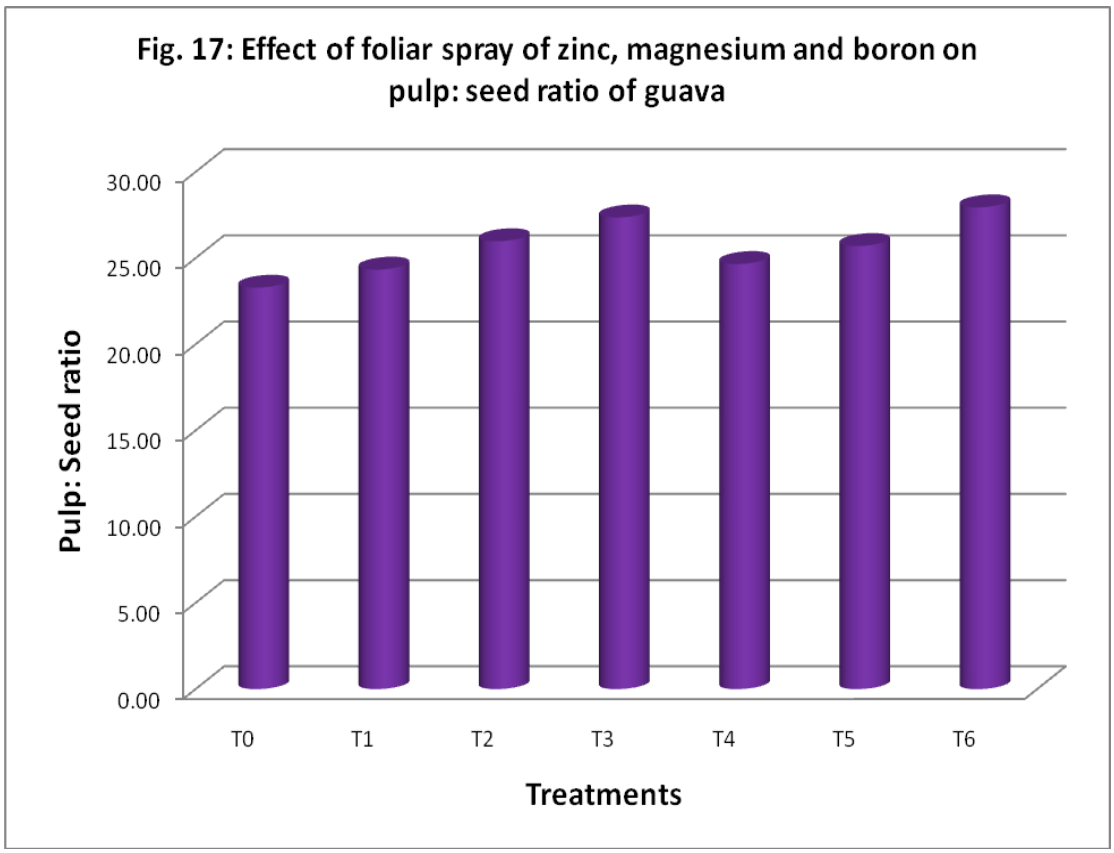


Fig. 17: Effect of foliar spray of zinc, magnesium and boron on pulp: seed ratio of guava
Pulp: Seed ratio
30.00
25.00
20.00
15.00
10.00
5.00
0.00
T0
T1
T2
T3
T4
T5
T6
Treatments

Fig. 18: Effect of foliar spray of zinc, magnesium and boron on TSS (^{0}Brix) of guava

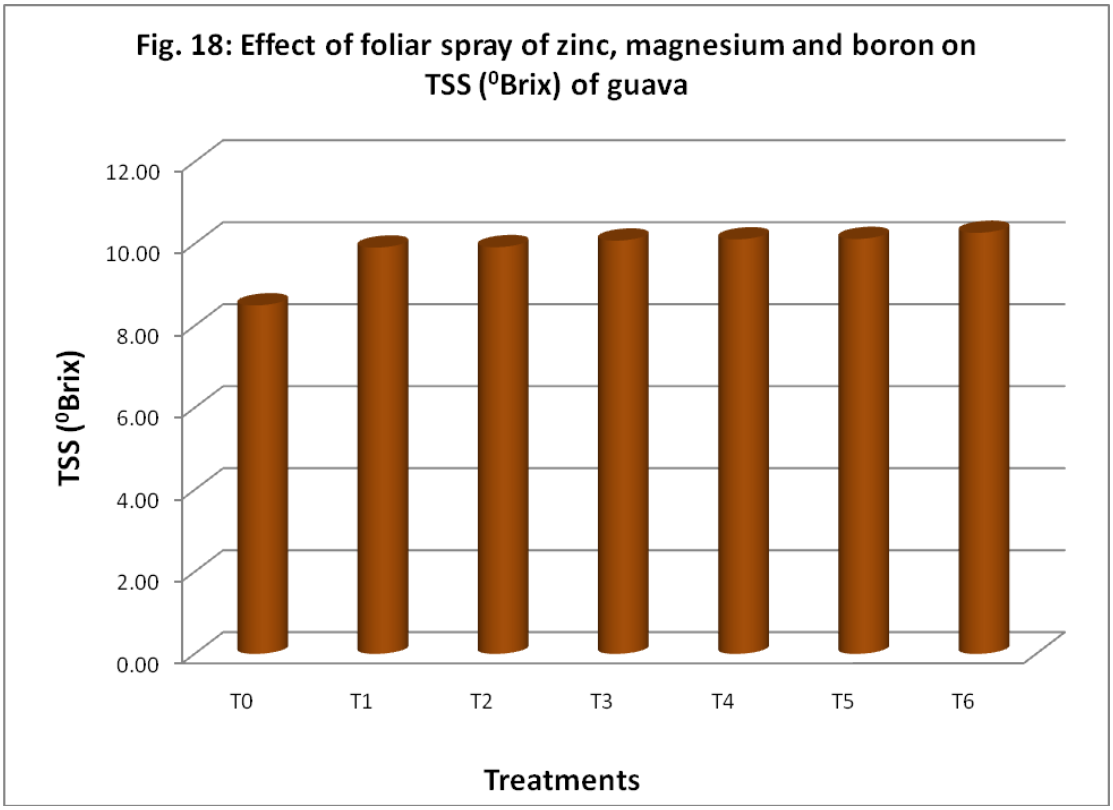


Fig. 19: Effect of foliar spray of zinc, magnesium and boron on acidity (%) of guava

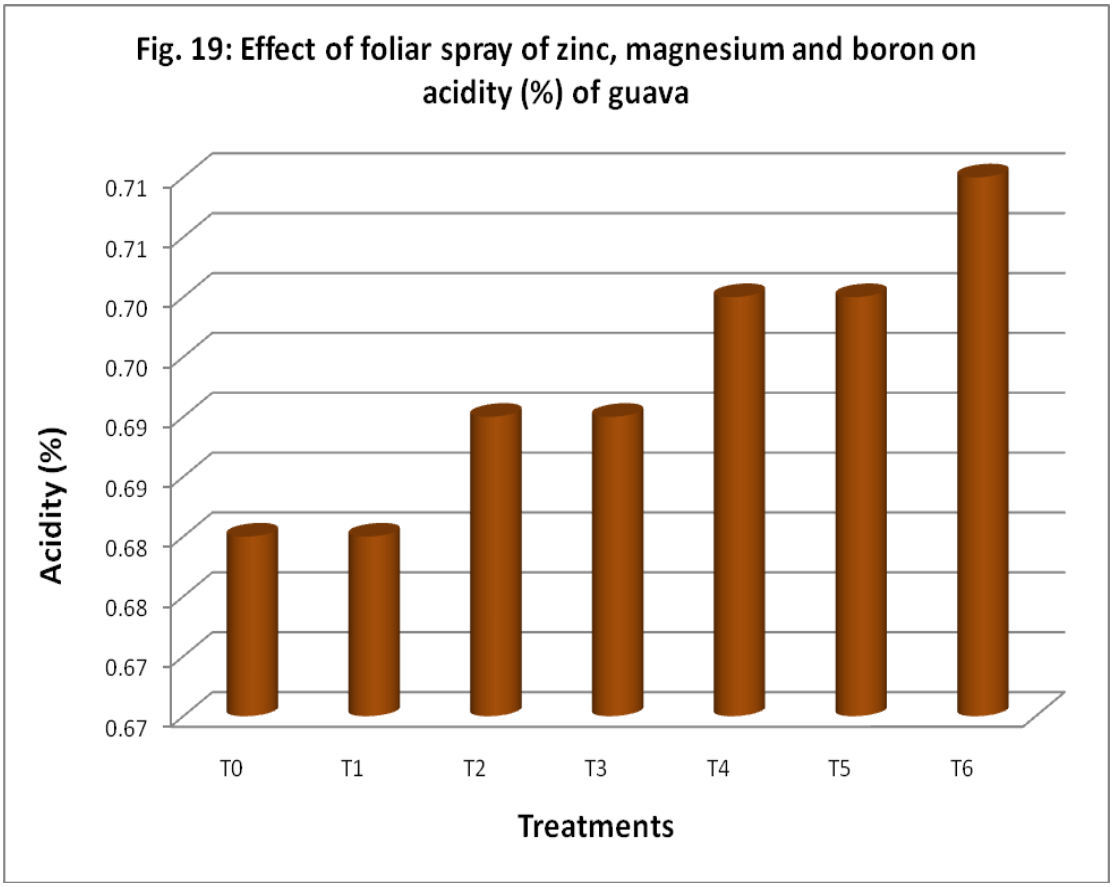


Fig. 20: Effect of foliar spray of zinc, magnesium and boron on number of fruit per plant of guava

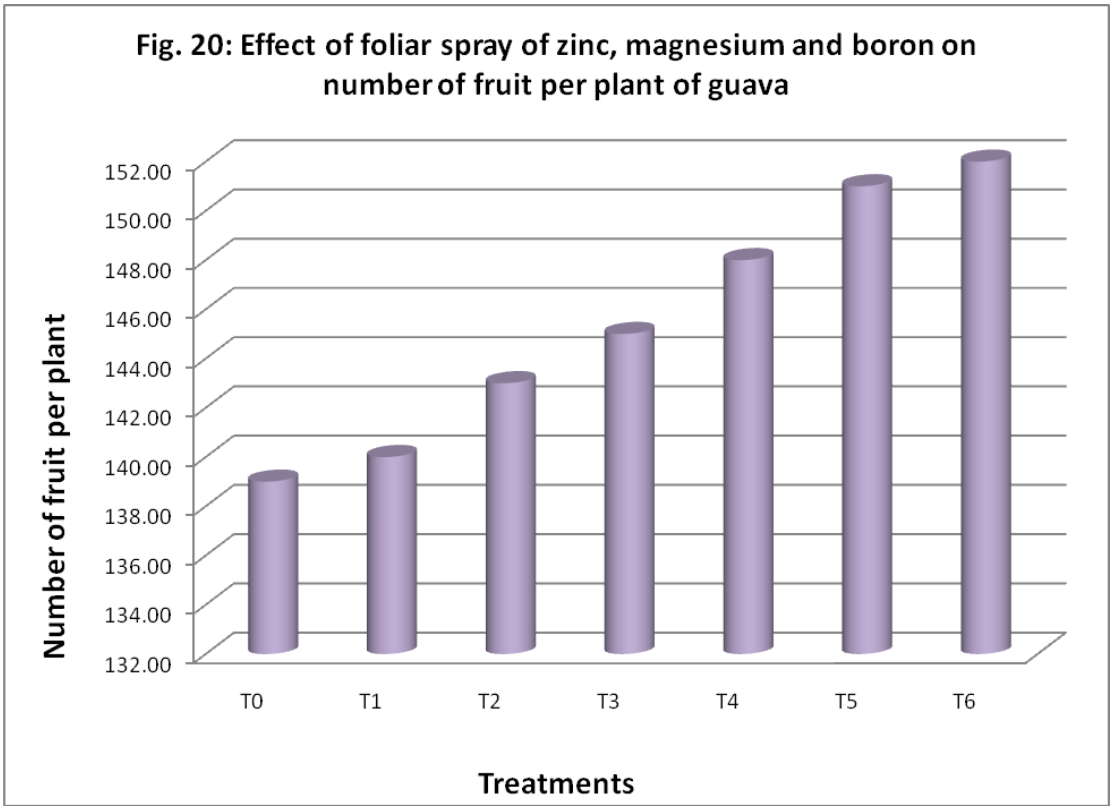
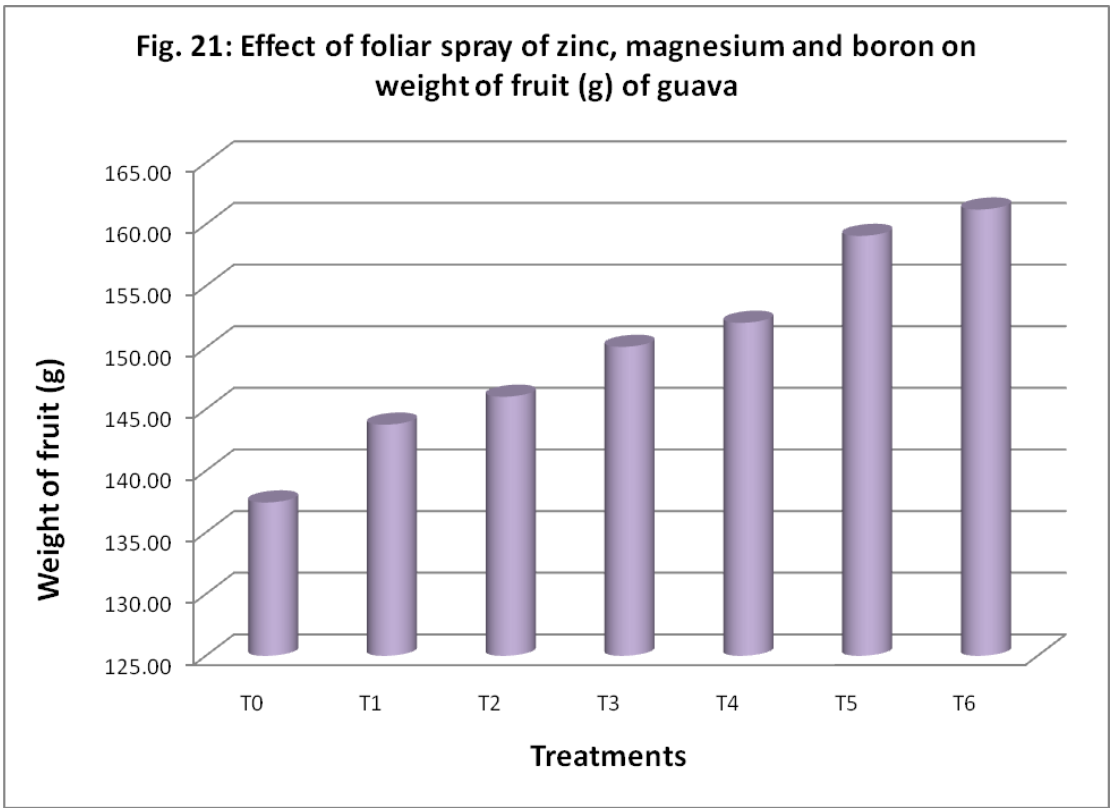


Fig. 21: Effect of foliar spray of zinc, magnesium and boron on weight of fruit (g) of guava



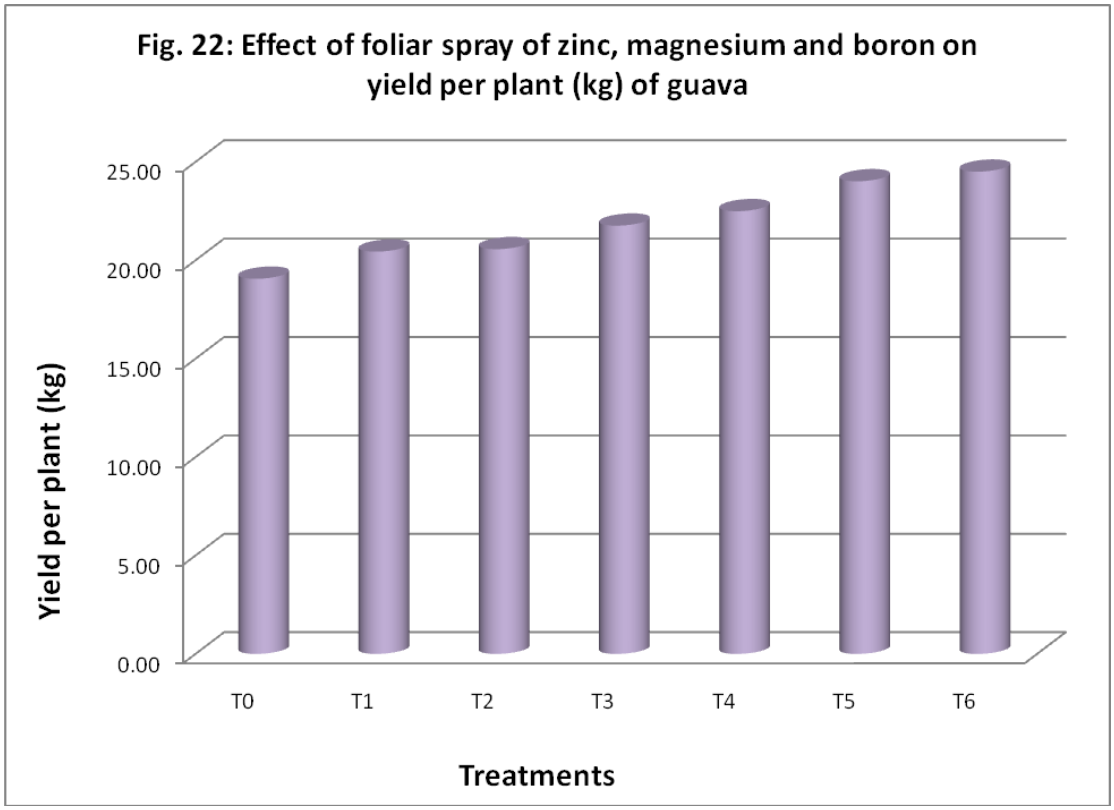


Fig. 22: Effect of foliar spray of zinc, magnesium and boron on yield per plant (kg) of guava
25.00
20.00
15.00
10.00
5.00
0.00
Yield per plant (kg)
T0
T1
T2
T3
T4
T5
T6
Treatments

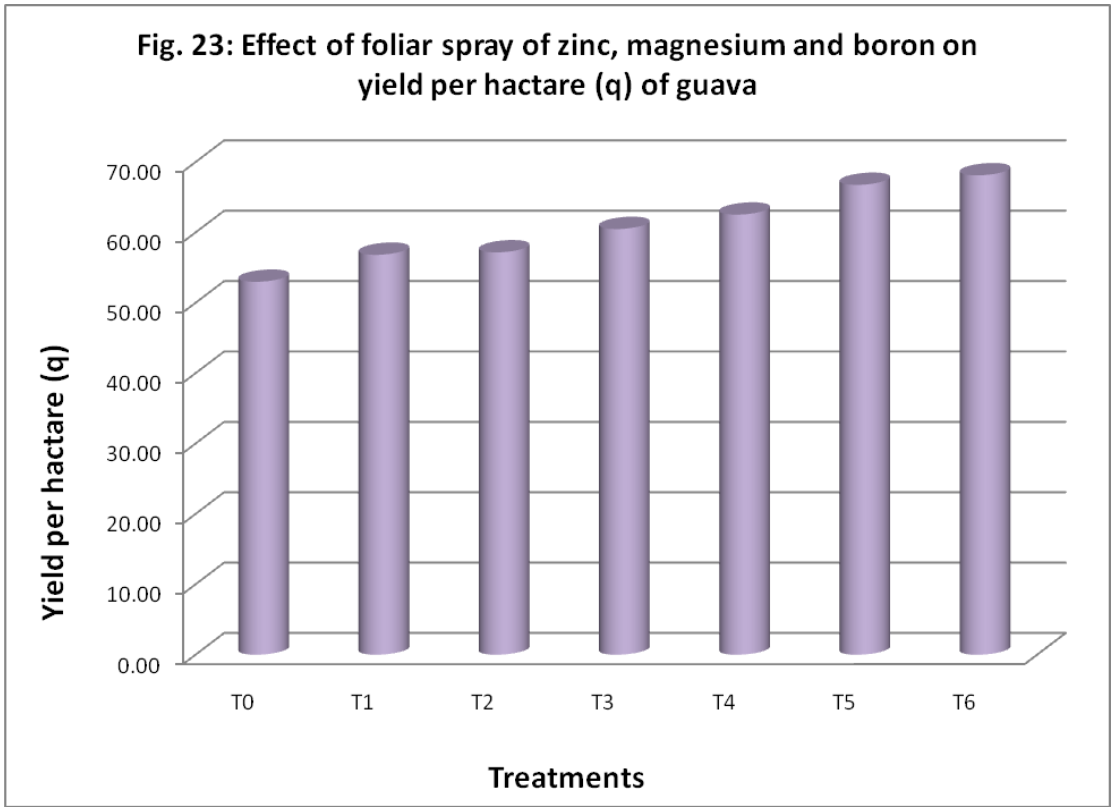


Fig. 23: Effect of foliar spray of zinc, magnesium and boron on yield per hactare (q) of guava
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Yield per hactare (q)
T0
T1
T2
T3
T4
T5
T6
Treatments

Chapter – V

DISCUSSION

An investigation entitled **"Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** was carried out at the College of Agriculture, Gwalior during the year 2017-18.

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

5.1 Vegetative Parameters

The vegetative parameters of the guava plant were significantly influenced by the different concentrations of magnesium sulphate, zinc sulphate and borax over the control. The mean maximum shoot length (13.85 cm) was recorded under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was followed by the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %), (12.98 cm), the mean maximum shoot diameter (0.53 mm) was recorded under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was followed by the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) and treatment T_4 (Zn @ 0.75 % +Mg @ 0.75 %), (0.49 and 0.48 mm), the number of leaves per shoot was non-significantly influenced by the foliar application of magnesium sulphate, zinc sulphate and borax over the control, whereas the minimum of all above was noticed under T_0 (Control) i.e. only spray of water.

Increase in shoot length by zinc spray is due to the fact that zinc plays an important part in the fundamental process involved in the cellular mechanism and respiration (Reed, 1946). The presence of zinc in chloroplast cell was also considered the possible cause of increased growth of plants (Wood and sibley, 1950). Improvement in vegetative growth was observed earlier with Zn by several workers; (Balakrishnan, 2000) in guava, Sharma and Bhattacharayya (1994) and Kundu and Mitra (1999) in guava, Chhonkar and Singh (1981). Ghosh (1986) also reported similar findings in guava.

The foliar sprays of Mg and Zn and B might have induced the synthesis of chlorophyll and thus lead to increase in cholorophyll content which in turn resulted in

higher vegetative growth Sharma and Bhattacharya (1994). The increase in number of leaves per shoot with Zn and Mg spray, may be because Zn has an obvious affect on photosynthesis and Mg is indispensable for photosynthesis. Improvement in vegetative growth of this present findings also are in conformity with several workers, Mansour and Sied (1981), Ghosh (1986), Sharma *et al.,* (1991), Dahiya *et al.,* (1993) and Balakrishnan (2001) in guava.

5.2 Reproductive Parameters:

The maximum (74.77 %) fruit setting percentage was observed under the treatment of T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), followed by (71.00 %) under the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %), whereas the minimum fruit setting (54.21%) percentage was noticed under T_0 (Control). The minimum fruit drop percentage (19.40 %) was found under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and maximum (24.98 %) in T_0 (control). The maximum fruit retention (55.37 %) was found in treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and minimum under treatment T_0 (control).

Maximum fruit retention and minimum fruit drop might be due to calcium and boron being main constituent of cell wall (middle lamella) of plant cell in the form of calcium pectate which play important role in strengthening of pedicel attached to proximal end of fruit resulted less fruit drop, similarly reduction in fruit drop by spray of borax can be due to the indirect action of zinc in auxin synthesis that delayed the formation of abscission layer during early stages of fruit development (Skoog 1940, Guardiola and Garcia, 2000).

According to Krishnamoorthy (1992) and Awasthi *et al.,* (1975) fruit drop is an abscission phenomenon controlled by the inter play of hormones. Zinc application at higher level increased the foliar zinc content which ultimately encourages the endogenous production of auxin thereby reducing fruit drop. Zinc is required for the synthesis of tryptophan a precursor of auxin thus helps in reducing fruit drop.

Higher fruit retention also might be due to stimulating effect of zinc and boron so the total fruit yield per tree also increased (Abbas *et al.,* 1999, Singh *et al*., 2001). Zinc application in the present experiment might have encouraged the endogenous production of auxin thereby reducing the fruit drop. These results are similar to the

findings reported by Ram (1977), Malik *et al.* (1990), Singh *et al.* (2008), Varma *et al*. (2008), Khan *et al*. (2009) and Shukla (2011) in aonla.

5.3 Physical parameters:

The maximum fruit length (6.61 cm) at harvest was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with T_5 (6.53 cm) (Zn @ 0.75 % + B @ 0.40 %). The maximum fruit diameter (6.69 cm) at harvest was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by T_5 (6.39 cm) (Zn @ 0.75 % + B @ 0.40 %). The maximum pulp thickness (3.44 cm) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by T_5 (Zn @ 0.75 % + B @ 0.40 %) (3.19 cm) and minimum was found under T_0 (control). The maximum fruit volume (154.21 ml) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (152.07 ml) and T_4- Zn @ 0.75 % +Mg @ 0.75 % (145.02 ml) and minimum (130.44 ml) under control (T_0). Non-significant influence on specific gravity of guava fruit. The maximum pulp weight (155.56 g) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (144.37 g ml) and minimum (131.66 g) under T_0 (control). Non-significantly influenced by the application of all the treatments. The maximum seed:pulp ratio (27.95) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (25.71) and minimum (23.29) at T_0 (control). The maximum pulp percentage (96.50 %) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (96.42 %) and minimum pulp per cent (95.82 %) under T_0 (Control). The minimum seed percentage (4.13 %) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (4.21%) and maximum seed per cent (4.92 %) under T_0 (Control).

This increase in length and width of guava fruits might be due to higher availability of zinc which has indirect role in hastening the process of cell division and cell elongation due to which size and weight would have improved. The results are in conformity with those reported by Arora and Singh (1972). Zinc was reported

to regulate the semi-permeability of cell wall thus mobilizing more water into the fruits, thereby increasing the size of fruit (Babu *et al.,* 1982). Meena *et al.* (2005) and Yadav *et al*. (2011) also reported the similar results in the guava.

Further Babu and Singh,1998 opined that the application of zinc and boron might have caused rapid synthesis of protein and translocation of carbohydrate which ultimately lead to increase in fruit weight which is directly correlated with total yield.

5.4 Chemical parameters of fruits:

The maximum total soluble solids (10.27 ^{0}Brix) was found in T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and minimum (8.50 ^{0}Brix) under T_0 (control).which acidity was Non-significantly influenced by micro nutrient application.

The enhanced physical growth parameters of guava fruits may be due to the fact that Zn acts as catalyst in the oxidation and reduction process and is also of great importance in sugar metabolism. The acid under the influence of zinc might have either been fastly converted into sugars and their derivatives by the reactions, involving the reversal of glycolytic pathway or be used in respiration or both. Decrease in acidity due to zinc spray is in agreement with the observations of Rajput and Chand (1976). Singh and Chhonkar (1983) recorded significant increase in total soluble solids, reducing sugar and ascorbic acid content in ‘Mrig-bahar’ guava pulp with foliar spray of 0.4 per cent zinc sulphate solution over control. This present investigation finds support from Rajput and Chand (1976), Pandey *et al*., (1988) and Prasad *et al*., (2005) in guava.

The beneficial effect of Mg in increasing total soluble solids content in guava fruit were also reported by Lal and Sen (2001). Decrease in acidity content by Mg spray has previously been shown by Ghosh (1986) and Lal and Sen (2001).

5.5 Yield parameters:

The maximum (152) number of fruits per tree was recorded with the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5, T_4 and T_3 (151, 148 and 145) and minimum (139) number of fruits per tree was in T_0 (Control) respectively. The maximum fruit weight (161.21 g) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5, T_4 and T_3 (159.07, 152.02 and 150.07) and minimum

(137.44) weight of fruits was in treatment T_0 (Control) respectively. The maximum fruit yield per tree (24.50 kg/tree) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5 (Zn @ 0.75 % + B @ 0.40 %) (24.02 kg/tree), and minimum fruit yield (19.06 kg/tree) was recorded in treatment T_0 (control). The maximum fruit yield per ha (68.12 q/ha) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5 (Zn @ 0.75 % + B @ 0.40 %) (66.67 q/ha), and minimum fruit yield (52.99 q/ha) was recorded in treatment T_0 (control).

The increase in fruit yield due to the increased growth and yield parameters may be due to the increased auxin production. Zinc acts as catalyst in the oxidation and reduction processes and is also great importance in the sugar metabolism which might have improved the physical characters of guava fruit and thus increased the yield per tree. Heavier fruits under zinc treatment might be due to the high level of auxin in the various parts of the fruit maintained by zinc application. The role of Zn in production of auxins is well known. The increase in the fruit weight by zinc spray was due to the significant increase in the fruit width and length. The increase in the yield under the effect of zinc sprays might be due to the fact that zinc is universallv claimed to be an essential micro nutrient and and it is considered indispensable for the growth of all organism. Effect of zinc spray on yield have earlier been also reported by Mansour and Sied (1981), Pandey *et al.* (1988), Sharma *et al.* (1991), Dahiya *et al.* (1993), Kundu and Mitra (1999), Balakrishnan (2000), Balakrishnan (2001), Bhatia *et al.* (2001), Meena *et al.,* (2005) and Tiwari and Shant (2010) in guava.

The increase in the yield parameters and yield in Mg treated plants may be on account of maximum availability of plant metabolites. Similar yield improvements with Mg application were observed by Kuznetsov and Koridze (1977) in Satsuma, Mann *et al.,* (1985) in sweet oranges and Bangali *et al.,* (1993) in guava.

5.6 Economics of the different treatments:

Maximum net returns (Rs 63347.11/ha) was recorded in T_5 (Zn @ 0.75 % + B @ 0.40 %) and minimum (Rs 48892.10/ha) in control. Whereas, maximum B:C ratio (2.71:1) was reported with T_3 (B @ 0.40%) while minimum (2.32:1) in T_1.

Chapter - VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

6.1. Summary:

The experiment entitled **"Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** was carried out at the College of Agriculture, Gwalior during the year 2017-18.

The results obtained and discussed in previous chapters are summarized below:

Significant improvement was recorded in the vegetative parameters (shoot length, number of leaves per shoot, shoot diameter), physical characteristics of fruit (fruit length, fruit width, fruit volume, specific gravity, pulp percentage, seed percentage, pulp: seed ratio), chemical characteristics (total soluble solids, acidity), and yield characteristics (number of fruits per tree, average fruit weight, Yield per tree, Yield per hectare) due to application of various chemicals over control. The results obtained from the present investigation are summarized below:

Vegetative Characters:

The mean maximum shoot length (13.85 cm) was recorded under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was followed by the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %), (12.98 cm), while minimum shoot length (9.08 cm) was recorded under control (T_0).

The mean maximum shoot diameter (0.53 mm) was recorded under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was followed by the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) and treatment T_4 (Zn @ 0.75 % +Mg @ 0.75 %), (0.49 and 0.48 mm), while minimum shoot diameter (0.31 mm) was recorded under control (T_0).

Non-significantly effect by the foliar application of Magnesium sulphate, Zinc sulphate and Borax over the control.

Reproductive Parameters:

The maximum (74.77 %) fruit setting percentage was observed under the treatment of T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), followed by (71.00 %) under the treatment T_5 (Zn @ 0.75 % + B @ 0.40 %), whereas the minimum fruit setting (54.21%) percentage was noticed under in T_0 (Control).

The minimum fruit drop percentage (19.40 %) was found under the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and maximum (24.98 %) in T_0 (control).

The maximum fruit retention (55.37 %) was found in treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and minimum (29.23 %) under treatment T_0 (control).

Physical parameters:

The maximum fruit length (6.61 cm) at harvest was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with T_5 (6.53 cm) (Zn @ 0.75 % + B @ 0.40 %), whereas minimum fruit length (5.34 cm) was recorded under T_0 (Control).

The maximum fruit diameter (6.69 cm) at harvest was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by T_5 (6.39 cm) (Zn @ 0.75 % + B @ 0.40 %), which were superior to all other treatments and minimum fruit diameter was (6.16 cm) in T_0 (control).

The maximum pulp thickness (3.44 cm) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by T_5 (Zn @ 0.75 % + B @ 0.40 %) (3.19 cm) and minimum pulp thickness was found (2.07 cm) under T_0 (control).

The maximum fruit volume (154.21 ml) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with

treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (152.07 ml) and T_4- Zn @ 0.75 % +Mg @ 0.75 % (145.02 ml) and minimum (130.44 ml) under control (T_0).

Various treatments had non-significant influence on specific gravity of guava fruit.

The maximum pulp weight (155.56 g) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (144.37 g ml) and minimum (131.66 g) under T_0 (control).

The seed weight was non-significantly influenced by the application of all the treatments.

The maximum seed:pulp ratio (27.95) was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (25.71) and minimum (23.29) at T_0 (control).

The maximum pulp percentage (96.50 %) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) which was at par with treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (96.42 %) and minimum pulp per cent (95.82 %) under T_0 (Control).

The minimum seed percentage (4.13 %) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) followed by treatment T_5 (Zn @ 0.75 % + B @ 0.40 %) (4.21%) and maximum seed per cent (4.92 %) under T_0 (Control).

Chemical parameters of fruits:

The maximum total soluble solids (10.27 ^{0}Brix) was found in T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%) and minimum (8.50 ^{0}Brix) under T_0 (control).

The application of Magnesium sulphate, Zinc sulphate and Borax showed non-significant influence on the acidity.

Yield parameters:

The maximum (152) number of fruits per tree was found by the application of treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5, T_4 and T_3 (151, 148 and 145) and minimum (139) number of fruits per tree was in T_0 (Control) respectively.

The maximum fruit weight (161.21 g) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5, T_4 and T_3 (159.07, 152.02 and 150.07) and minimum (137.44) weight of fruits was in treatment T_0 (Control) respectively.

The maximum fruit yield per tree (24.50 kg/tree) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5 (Zn @ 0.75 % + B @ 0.40 %) (24.02 kg/tree), and minimum fruit yield (19.06 kg/tree) was recorded in treatment T_0 (control).

The maximum fruit yield per ha (68.12 q/ha) was found in the treatment T_6 (Zn @ 0.75 % + Mg @ 0.75%+ B @ 0.40%), which was at par with treatments T_5 (Zn @ 0.75 % + B @ 0.40 %) (66.67 q/ha), and minimum fruit yield (52.99 q/ha) was recorded in treatment T_0 (control).

(D) Economies of different treatment

Maximum net returns (Rs 63347.11/ha) was recorded in T_5 (Zn @ 0.75 % + B @ 0.40 %) and minimum (Rs 48892.10/ha) in control. Whereas, maximum B:C ratio (2.71:1) was reported with T_3 (B @ 0.40%) while minimum (2.32:1) in T_1.

6.2. Conclusions:

On the basis of results obtained in present investigation entitled **"Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** it is concluded that foliar application of zinc sulphate, magnesium sulphate and borax had significantly improved the vegetative growth, reproductive parameters, physical characters, chemical parameters and yield attributing parameters of guava plant.

6.3. Suggestions for further work:

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

1. The present investigation should be repeated in different agro ecological conditions to confirm the findings.
2. The experiment should be attempted with other chemical levels.

3. Experiment should be done with other varieties.
4. Experiments on secondary and micro nutrients must include role in plant analysis in nutrients under study.

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APPENDICES

APPENDICES I:- VEGETATIVE CHARACTERS:

Analysis of variance for Shoot length (cm)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	0.000152	7.62E-05	0.165803	3.89
TREAT	6	42.6798	7.1133	15479.72	3.00
Error	12	0.01	**0.00046**		
Total	20	42.68547			

Analysis of variance for Shoot diameter (mm)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	0.0008	0.0004	8	3.89
TREAT	6	0.094114	0.015686	313.7143	3.00
Error	12	0.00	**5E-05**		
Total	20	0.095514			

Analysis of variance for Number of leaves per shoot

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	7.735438	3.867719	11.8653	3.89
TREAT	6	3.898629	0.649771	1.993353	3.00
Error	12	3.91	**0.325969**		
Total	20	15.5457			

APPENDICES II: REPRODUCTIVE PARAMETERS:

Analysis of variance for Fruit setting (%)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	141.603	70.80151	448.0874	3.89
TREAT	6	1110.424	185.0707	1171.272	3.00
Error	12	1.90	**0.158008**		
Total	20	1253.923			

Analysis of variance for Fruit drop (%)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	16.86528	8.432641	860.5217	3.89
TREAT	6	70.55606	11.75934	1200	3.00
Error	12	0.12	**0.009799**		
Total	20	87.53893			

Analysis of variance for Fruit retention (%)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	59.04695	29.52348	102.183	3.89
TREAT	6	2080.277	346.7128	1200	3.00
Error	12	3.47	**0.288927**		
Total	20	2142.791			

APPENDICES III: PHYSICAL PARAMETERS:

Analysis of variance for Size of fruit (cm) (Fruit length cm)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	0.002657	0.001329	0.768595	3.89
TREAT	6	3.266057	0.544343	314.9091	3.00
Error	12	0.02	**0.001729**		
Total	20	3.289457			

Analysis of variance for Size of fruit (cm) (Fruit Width cm)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	0.00161	0.000805	169	3.89
TREAT	6	0.527057	0.087843	18447	3.00
Error	12	0.00	**4.76E-06**		
Total	20	0.528724			

Analysis of variance for Pulp thickness (cm)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	0.672385	0.336193	265.8182	3.89
TREAT	6	3.83946	0.63991	505.9593	3.00
Error	12	0.02	**0.001265**		
Total	20	4.527022			

Analysis of variance for Fruit volume (cc)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	124.4928	62.24641	1.845423	3.89
TREAT	6	1273.439	212.2399	6.292288	3.00
Error	12	404.76	**33.73016**		
Total	20	1802.694			

Analysis of variance for Specific gravity

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	0.000888	0.000444	76.02423	3.89
TREAT	6	0.000167	2.79E-05	4.770611	3.00
Error	12	0.00	**5.84E-06**		
Total	20	0.001125			

Analysis of variance for Pulp weight (g)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	19.83711	9.918557	0.308311	3.89
TREAT	6	1286.91	214.485	6.667105	3.00
Error	12	386.05	**32.17063**		
Total	20	1692.795			

Analysis of variance for Seed weight (g)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	12.07143	6.035714	169	3.89
TREAT	6	0.0408	0.0068	0.1904	3.00
Error	12	0.43	**0.035714**		
Total	20	12.5408			

Analysis of variance for Seed /pulp ratio

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	180.6908	90.3454	152.8079	3.89
TREAT	6	49.77809	8.296348	14.03223	3.00
Error	12	7.09	**0.591235**		
Total	20	237.5637			

Analysis of variance for Pulp per cent

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	4.365264	2.182632	204.1167	3.89
TREAT	6	1.027239	0.171207	16.011	3.00
Error	12	0.13	**0.010693**		
Total	20	5.52082			

Analysis of variance for Seed per cent

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	0.698268	0.349134	1712.929	3.89
TREAT	6	1.467525	0.244588	1200	3.00
Error	12	0.00	**0.000204**		
Total	20	2.168239			

APPENDICES IV: CHEMICAL PARAMETERS OF FRUITS:

Analysis of variance for TSS (^{0}Brix)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	10.52711	5.263557	36.8449	3.89
TREAT	6	6.601714	1.100286	7.702	3.00
Error	12	1.71	**0.142857**		
Total	20	18.84311			

Analysis of variance for Acidity (%)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	0.0038	0.0019	4.956522	3.89
TREAT	6	0.002229	0.000371	0.968944	3.00
Error	12	0.00	**0.000383**		
Total	20	0.010629			

APPENDICES IV : YIELD PARAMETERS:

Analysis of variance for No. of fruit per tree

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	10.57143	5.285714	0.302865	3.89
TREAT	6	473.1429	78.85714	4.518417	3.00
Error	12	209.43	**17.45238**		
Total	20	693.1429			

Analysis of variance for Average fruit weight (g)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	62.63283	31.31641	0.92844	3.89
TREAT	6	1273.439	212.2399	6.292288	3.00
Error	12	404.76	**33.73016**		
Total	20	1740.834			

Analysis of variance for Fruit yield (kg/ tree)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	1.804579	0.90229	1.37745	3.89
TREAT	6	70.68411	11.78068	17.98458	3.00
Error	12	7.86	**0.655043**		
Total	20	80.34921			

Analysis of variance for Fruit yield (q/ ha)

S.V	Df	SS	MSS	Fcal	Ftab
REP	2	13.94651	6.973256	1.37745	3.89
TREAT	6	546.2751	91.04584	17.98458	3.00
Error	12	60.75	**5.062438**		
Total	20	620.9708			

ANNEXURE - I

Cost of Cultivation (Treatment Cost)

Treat.	Quantity kg/ha			Rate/kg			Price/ha		
	ZnSo4	MgSo4	Borex	ZnSo4	MgSo4	Borex	ZnSo4	MgSo4	Borex
T0 -	0	0	0	500	450	500	0.00	0.00	0.00
T1-	4.5	0	0	500	450	500	2250.00	0.00	0.00
T2-	4.5	0	0	500	450	500	2250.00	0.00	0.00
T3-	0	0	2.4	500	450	500	0.00	0.00	1200.00
T4-	4.5	4.5	0	500	450	500	2250.00	2025.00	0.00
T5-	4.5	0	2.4	500	450	500	2250.00	0.00	1200.00
T6-	4.5	4.5	2.4	500	450	500	2250.00	2025.00	1200.00

Total cost of Cultivation without treatments- 20000/-ha

Plant to Plant distance – 6m X 6m

Total no. of plants/ha- 278

Price of guava produce- 1300/quntal

VITA

The author of this thesis, Mr**. RAJESH CHOUHAN** S/o Shri. Manjariya ji Chouhan was born on 12 May 1988 at Village- Kotba, Post- Gajgota, Tehshil- Dahi, Dist:-Dhar (MP), 454331. He passed Secondary Examination in the year 2007 and Senior Secondary Examination in the year of 2009 from Sunshine, H.S.S. Indore Dist:-Indore (MP), with 47.8 % and 63.0 % respectively.

He joined College of Agriculture, Gwalior (M.P) in 2011 and completed B.Sc. (AGRICULTURE) in the year 2016 with 1st division securing an OGPA of 6.54 out of 10 point scale.

After graduation he got admission in (M.Sc. Horticulture- Fruit Science) in college of Agriculture, Gwalior with specialization in Fruit Science. He has completed the entire course requirement for the above said Master's degree in the year 2019 with an OGPA 68.1 out of 10 point scale.

He was allotted an interesting research problem entitled **'Effect of foliar spray of zinc, magnesium and boron on growth yield and quality of guava (*Psidium guajava* L.)"** of his choice for thesis work, which has been duly completed by his and presented in the form of this thesis.

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