PESTS STATUS IN HIGH DENSITY GUAVA (*Psidium guajava*) PLANTATION

By

Mr. JADHAV SRIKANT UTTAMRAO

(Reg. No. 013/100)

A Thesis submitted to the

**MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI - 413 722, DIST.AHMEDNAGAR,
MAHARASHTRA, INDIA**

In partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURAL ENTOMOLOGY

**DEPARTMENT OF AGRICULTURAL ENTOMOLGY
POST GRADUATE INSTITUTE
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APPROVED BY

Dr. R. V. DATKHILE
(Chairman and Research Guide)

Prof. S. A. PAWAR
(Committee Member)

Dr. S. S. JADHAV
(Committee Member)

Dr. C. A. Nimbalkar
(Committee Member)

**DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
POST GRADUATE INSTITUTE
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722, DIST. AHMEDNAGAR**

2015

CANDIDATE'S DECLARATION

I here by declare that this thesis

or

part of this thesis

has not been submitted by me

or

any other person

to any other

University or Institution

for

Degree or Diploma.

Place: M.P.K.V. Rahuri.
Date: / /2015 **(S. U. JADHAV)**

Dr. R.V. DATKHILE
Entomologist (Fruits)
AICRP on Fruit crops
Department of Horticulture
Mahatma Phule Krishi Vidyapeeth
Rahuri, 413 722, Dist. Ahmednagar
Maharashtra, (India)

CERTIFICATE

This is to certify that the thesis entitled, **"PESTS STATUS IN HIGH DENSITY GUAVA (*Psidium guajava*) PLANTATION"** submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ENTOMOLOGY**, embodies the results of a *bona fide* research carried out by **Mr. JADHAV SRIKANT UTTAMRAO,** under my guidance and supervision and that no part of the thesis has been submitted for any other Degree or Diploma.

The assistance and help received during the course of this investigation have been acknowledged.

Place: M.P.K.V. Rahuri **(R. V. DATKHILE)**
Date: / /2015 **Research Guide**

Dr. B. R. Ulmek
Associate Dean
Post Graduate Institute
Mahatma Phule Krishi Vidyapeeth
Rahuri, 413 722, Dist. Ahmednagar
Maharashtra, (India)

CERTIFICATE

This is to certify that the thesis entitled **"PESTS STATUS IN HIGH DENSITY GUAVA (*Psidium guajava*) PLANTATION"** submitted to the Mahatma Phule Krishi Vidyapeeth, Rahuri for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ENTOMOLOGY,** embodies the results of a *bona fide* research carried out by **Mr. JADHAV SRIKANT UTTAMRAO,** under the guidance and supervision of **Dr. R. V. DATKHILE,** Entomologist (fruits), AICRP on fruit crops, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri and that no part of the thesis has been submitted for any other Degree or Diploma.

Place: M.P.K.V. Rahuri **(B. R. Ulmek)**
Date: / /2015 Associate Dean

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Place: Rahuri (S. U. JADHAV)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF ABBREVIATIONS

%	:	Per cent
/	:	Per
+	:	Plus
^{0}C	:	Degree Celsius
a. i.	:	Active ingredient
Av.	:	Average
BSS	:	Bright sunshine hours
C.D.	:	Critical difference
cm	:	centimeter (s)
DAS	:	Days after spraying
e.g.	:	example gratia (for example)
EC	:	Emulsifiable concentration
et al.,	:	*et alli* (and others)
etc.	:	et cetera (and others)
Fig.	:	Figure (s)
g	:	gram (s)
ha	:	hectare (s)
hr	:	hours
i.e.	:	that is
kg	:	kilogram (s)
l	:	litre (s)
Ltd.	:	Limited
m	:	meter
mg	:	Milligram (s)
ml	:	Milliliter
MT	:	Metric tonne (s)
M/s	:	Messers
No.	:	Number

N.S.	:	Non significant
q	:	quintals
r	:	Correlation coefficient
RH	:	Relative humidity
RH-I	:	Relative humidity (morning hours)
RH-II	:	Relative humidity (evening hours)
S.E.	:	Standard error
SP	:	Soluble powder
Sr.	:	Serial
Spp.	:	species
T	:	Treatment
T.max	:	Maximum temperature
T.min	:	Minimum temperature
t	:	Tonne (s)
var.	:	variety
viz.	:	Videlicet (namely)
WP	:	Wettable powder
WSC	:	Wettable soluble concentration
wt.	:	weight

ABSTRACT

PESTS STATUS IN HIGH DENSITY GUAVA (*Psidium guajava*) PLANTATION

By

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Research Guide	:	**Dr. R. V. Datkhile**
Department	:	**Agricultural Entomology**

The field investigations were carried out at the Instructional cum Research orchard of high density guava, Department of Horticulture, MPKV, Rahuri (M.S.) from July to October, 2014 to study the pests status of fruit borers and sucking pests and correlation of these pests with abiotic factors.

The experiment was conducted in Randomized block design with five plant spacing viz. 1.0 x 1.0 m, 1.5 x 1.5 m, 1.5 x 2.0 m, 2.0 x 2.0 m and 6.0 x 6.0 m replicated four times. The present studies were carried to worked out the percentage infestation in guava fruit due to fruit flies, castor capsule borer and anar caterpillar and population of thrips, whiteflies and mealy bugs per three leaves per plant.

The result of studies indicated that, the incidence of fruit flies *(Bactrocera dorsalis*) was noticed in 1st week of July, 2014 (27th M.W.). The infestation was maximum (11.0%) in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m plant spacing. Whereas, standard recommended plant spacing 6.0 x 6.0 m recorded least (2.95%) fruit infestation in 2nd week of August, 2014. The infestation of fruit fly was maximum in the month of August as compared to July, September and October, 2014. The fruit fly infestation was highly significant positive correlation with minimum temperature and relative humidity (RH-I and RH-II) and highly significant negatively correlated with BSS hrs.

The incidence of *D. punctiferalis* was noticed in 1st week of July (27th M.W.). The infestation was maximum (9.05%) reported in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m (7.65%) plant spacing. Whereas, plant spacing 2.0 x 2.0 m were recorded significantly least 4.13% infestation and it was at par with 6.0 x 6.0 m plant spacing. The infestation of castor capsule borer was maximum during early fruiting period of crop from June to July, 2014 as compared to September and October, 2014. The castor capsule borer infestation has highly significant positive correlation with minimum temperature and significant negative correlation with BSS hours.

The result of studies indicates that, the peak incidence of anar caterpillar was noticed in 3rd week of August (34th M.W.). The maximum (7.79%) infestation was observed in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m plant spacing. Whereas, standard recommended plant spacing 6.0 x 6.0 m recorded least (3.60%) fruit infestation. The anar caterpillar infestation had highly significant positive correlation with minimum temperature and morning humidity and non significant negative correlation with other parameters.

Among the treatments, 6.0 x 6.0 m and 2.0 x 2.0 m plant spacing were recorded significantly less incidence of thrips**,** spiraling whiteflies and mealy bugs. The maximum pest population of these pests were registered in the 1.0 x 1.0 m followed by 1.5 x 1.5 m plant spacing.

The maximum number of thrips (1.22/leaf) were recorded in 38th M.W. when the max. and min. temperature were 31.9 and 20^{0}C, respectively and humidity at morning and evening were 70 and 40%, respectively. The thrips incidence had significant positive correlation with minimum temperature and non significant positive correlation with morning and evening humidity.

The maximum number of spiraling whiteflies (2.14/leaf) and mealy bug (1.92/leaf) were recorded in 44th M.W. when the max. and min. temperature were 32 and 14^{0}C, respectively and humidity at morning and evening ranged from 56 to 36%, respectively. Mealy bug and spiraling whitefly population had significant positive correlation with sunshine hours and highly significant negative correlation with morning and evening humidity and minimum temperature.

The maximum yield of 12 t/ha was recorded in 1.0 x 1.0 m plant spacing and it was at par with 2.0 x 2.0 m, 1.5 x 1.5 m and 2.0 x 1.5 m plant spacing, respectively. However, maximum (10.18 kg) yield per plant was recorded from standard recommended plant spacing of 6.0 x 6.0 m for one bahar only.

Pages 1 to 80

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1. INTRODUCTION

Guava *(Psidium guajava)* is an important fruit crop in tropical and subtropical regions of the countries due to the hardy nature of tree and prolific bearing even in marginal land. The traditional system of cultivation has often posed problem in attaining desired levels of productivity due to large tree canopy, hence the need arises across to improve the existing production system, to improve productivity. The high density meadow orcharding facilitated to enhance production and quality of fruits. The high density and meadow orcharding is a method of fruit cultivation of dwarf tree with modified canopy. The meadow orchard system of guava accommodates 10000 plant per ha. planted at 1.0 x 1.0 m spacing and managed with regular topping and hedging, especially during initial stages. Topping and hedging in guava are helping in controlling tree size and extending fruit availability.

The fruits are demanded in domestic as well as International markets and are traded in more than 60 countries. Major guava producing countries are India, Brazil, Mexico, South Africa, Pakistan, Kenya, and Cuba. The International trade of guava is currently limited to processed product exported to United States, Japan and Europe. In India major guava producing state are Maharashtra, Uttar Pradesh, Andhra Pradesh, Madhya Pradesh, Gujrat and Tamil nadu.

Guava contributes 4.00 per cent of the total fruit production which is around 26.11 million tonnes from 233 thousand hectares and the productivity is around 9.9 tonnes per ha. Maharashtra is the leading guava producer both in area and production, followed by Bihar and Uttar Pradesh. In

Maharashtra, the guava is grown on a area of 40 thousand hectares with a production of 0.5 million tonnes, giving an average productivity of 9.8 tonnes per ha (Anonymous, 2013), but its productivity is highest in Karnataka followed by Punjab, Bengal and Gujarat.

The insect pest problems affect both quality and quantity of guava fruits. About 80 species of insect pests have been recorded on guava but only few of them had been identify as pest of regular occurrence and causing serious damage. These are fruit fly, bark eating caterpillar and scale insect. The bark eating caterpillar and fruit fly are wide distributed, while scale insect and mealy bug are more common in south India and tea mosquito bug, *Helopeltis antonii* in central India. Intensive surveys of guava growing regions of Uttar Pradesh have revealed that, the incidence of fruit borer, *D. isocrates* (2.5-22.5%) with crops loss ranged from 5.00 to 30.00% (Singh *et al.*, 2007). Fruit fly is major limiting factor in production of rainy season guava. Infestation of fruit fly was ranged from 20.00 - 46.00 % with crop loss 16 to 40 % (Singh *et al.*, 2007).

Fruit flies causes direct damage by puncturing the fruit skin to lay eggs. During egg laying bacteria from the intestinal flora of the fruit fly are introduced into the fruit. These bacteria cause rotting of the tissues surrounding the egg. When the eggs hatch, the maggots feed on the flesh making galleries. These provide entry for pathogens and increases the fruit decay, making fruits unsuitable for human consumption. Generally, the fruit falls to the ground as, or just before the maggots pupate. In fruits for export, fruit flies cause indirect losses resulting from quarantine restriction that are imposed by importing countries to prevent entry of fruit flies.

The losses caused to fruits by fruit flies varied according to species of fruit fly and host plant species. The most serious pest species reported is the oriental fruit fly (*B. dorsalis*), which causes 5-100 per cent loss to various fruits. Highest loss of 80 per cent in guava fruit was reported by Jalaluddin *et al.* (1999). The maximum activity of fruit flies, *Bactrocera* spp. was observed in the month of September coinciding with fruiting season of guava. Whereas, lowest activity was reported in the month of May (Dale, 2002). The meteorological parameters decide the different peaks of the fruit fly population.

The infestation of the sucking pests is more because of drying and dying of affected leaves and twigs which adversely affect growth, flowering and fruiting and finally yield level. Infestation of scale insects, aphids and mealy bugs on leaves, shoots and fruits was also common in most of the orchards. The infestation of mite and shoot borer caused the drying and dying of affected leaves and twigs which adversely affect growth of plants, flowering and fruiting of guava. The red-banded thrips feed on leaves and fruit surface causing death to the young shoots of guava trees. Young guava fruits will be scrabbed after attack by this pest, thus reducing the aesthetic value of the harvested fruits. Guava also infested with many insect pests, of which spiraling whitefly (*Aleurodicus disperses)* has become a serious pest in recent years. It was reported to cause 64 per cent leaf infestation in guava with 80 per cent fruit losses (Rashid *et al.,* 2003). Since the degree of incidence of spiraling whitefly changes with the season, it is desirable to understand the seasonal incidence and abundance of spiraling whitefly.

Keeping this in view, the present study was carried out to investigate the levels of effect on different plant spacings on infestation of guava insect pests and the relationship between major pests of guava with abiotic factors and effect of plant spacing on pest incidence with the following objectives.

i. To study the population of different pests in high density guava plantation.
ii. To study the correlation of major pests with weather parameters in high density guava plantation.

2. REVIEW OF LITERATURE

The literature pertaining to the topic under study is reviewed and presented under different headings.

2.1 The status of different pests in high density guava plantation

Roger *et al.* (1989) reported peak activity of *B. dorsalis* during spring and autumn in guava belt, above costal agricultural areas of Hawaiian Island.

Boscan *et al.* (1989) reported population peaks of fruit fly in guava in September 1980 and 1982 and in October 1981. The population level was close to zero from April to June 1981.

Vargas *et al.* (1990) studied the population dynamics, habitat preference and seasonal distribution pattern of oriental fruit fly and melon fruit fly in the agricultural area. During period of peak of guava, production number of oriental fruit fly increased on farm and melon fruit fly abundance on farms.

Vargas *et al.* (1991) studied the population dynamics of *B. dorsalis* and *B. cucurbitae* from 1987 to 1989 by fruit collections and male trap captured. They found that major hosts of *B. dorsalis* were wild strawberry and guava. Whereas, major host of *B. cucurbitae* were cultivated trunk crops on farms. Further, they reported that, during period of peak, number of *B. dorsalis* increased on farms and during periods of peak crop production, *B. cucurbitae* increased in habitats surrounding farms.

Dong *et al.* (1995) recorded the peak activity of *B. dorsalis* in the month of January-March and July-November in guava orchard in Guangzhou area of China. The population peak of *A. striata* larvae was observed in June, whereas the lowest level occurred in September in Coasta Rica.

Zhi Ying *et al.* (1995) reported that the second generation of *B. dorsalis* was the most important found feeding on mango, peach and guava fruits. Further they reported that the peak period of adult catches was during June-July with the exception of citrus and sweet orange orchards during Sept.-Oct. and Oct.-Dec., respectively. They also concluded that the peak period and number of adult occurrence differed year to year.

Makhmoor and Singh (1998) reported highest trap catches of *B. dorsalis* during July in Jammu and Kashmir at maximum and minimum temperatures 33.6 and 22.5 ^{0}C and the relative humidity was 90.3 and 57 per cent, respectively. The maximum (427.2 and 517.0 males/trap) catches of *B. dorsalis* and *B. zonata* in Haryana was recorded during September. There was a significant positive correlation between the trap catches and maximum and minimum temperature.

Verghese *et al*. (1998) monitored *B. dorsalis*, a serious pest of mango and guava, using methyl eugenol traps at an experimental farm in Karnataka. The trap catches were higher between the months of May to August, which synchronized with the maturity of several susceptible mango cultivars. The trap catch study carried out for two years with abiotic factors revealed, significant positive correlation with minimum temperature and wind speed. The trap data of the week were observed to serve as a useful index to predict fruit fly population of subsequent weeks, especially 8th week with the maximum co-efficient of determination equal to 36 per cent, based on a liner model.

Jalaluddin *et al.* (1999) reported that *B. correcta* was recorded for the first time in Tamil nadu, India, in 1995, where it caused guava fruit damage ranging from 60 to 80 per cent. The adults laid eggs in fruit causing blemishes and discoloration and the larvae bored inside the fruit. The other important species recorded were *B. dorsalis* and *B. zonata* which were less abundant than *B. correcta.*

Rodriguez *et al.* (1999) reported that the population of *A. striata* tended to increase from August to September and reached the highest level in late November and early December of the following years in Monwagas state of Venezuela.

Chaudhary and Jamal (2002) observed peak activity of *B. zonata* and *B. dorsalis* from August to October, which coincide with the maturity of guava under various environmental conditions of Rawalpindi, Pakistan. Similarly, in guava the maximum (10.76 to 14.74 per cent) infestation of *B. zonata* was observed in the month of August to September in Pakistan.

Mani and Krisnamoorthy (2000) studied the population dynamics of spiraling whitefly *(Aleurodicuss disperses)* and its natural enemies on guava. The population of whitefly was observed high from the month of March to June (164-218 whiteflies per plant) and low from October to January.

Jalaluddin *et al.* (2001) observed the distinct population peak of *B. correcta* and it was recorded from July to August in Tamil nadu. The data on weekly catches showed significant positive correlation with maximum and minimum temperature, morning relative humidity and rainfall, whereas, it showed negative correlation with sunshine hours.

Sarada *et al.* (2001) recorded the highest population of *Bactrocera spp.* during November and lowest during March in guava orchard in Andhra Pradesh. In correlation study, positive correlation with relative humidity, rainfall and negative with maximum temperature was observed.

Gallani *et al.* (2002) studied the population dynamics of fruit fly in guava and nectrin orchards in Islamabad. The results revealed that, flies caught in the traps were higher number from May to August and their population was peak in month of July.

Morde (2003) studied the fruit fly complex of the Konkan region and reported six fruit fly species *viz.*, *Bactrocera dorsalis*, *B. correcta*, *B. zonata*, *B. caryeae*, *B. cucurbitae* and *B. tau*. Out of these six species, three fruit fly species *viz.*, *B. dorsalis*, *B. caryeae* and *B. zonata* were attracted to the methyl eugenol trap installed in guava orchard in Dapoli area.

Rashid (2003) studied the seasonal abundance of spiraling whitefly, *A. dispersus* on guava and its control were conducted. The seasonal distribution of spiraling whitefly indicated that winter months December, January and February were major peak period of infestation. Adult whitefly started to infest the guava plants in September and increased to maximum in January and Whitefly infestation decreased to zero from April and continued to August.

Kawashita *et al.* (2004) surveyed population of *Bactrocera* fruit flies from September, 1997 to September, 1999 in Sri Lanka using Steiner type traps with two kinds of lure (methyl eugenol and cue lure) in one fixed point. Fifteen species of fruit flies belonging to genus *Bactrocera* were captured in total. *B. dorsalis* and *B. kandiensis* were dominant in traps with methyl eugenol, and *B. cucurbitae* and *B. nigrofemoralis* were captured mainly by cue lure. The populations of fruit flies were not of high density every year, even in a tropical zone such as Sri Lanka. In particular, few fruit flies were captured from September, 1997 to March, 1998 and from September to December, 1998. *B. correcta* was found in traps by using methyl eugenol from October to February and *B. zonata* were attracted by methyl eugenol from April to July.

Chin *et al.* (2006) studied the biology of the spiraling whitefly and monitored its control by the introducing parasite *Encarsia.* The study reported that spiraling whitefly attacks a large range of plants including vegetables, fruit trees, ornamentals, native plants and weeds.

Muhammad (2006) studied the occurrence of insect pests on guava tree. Result revealed that, principle and key pest identified on guava include fruit fly, mealy bug, anar butterfly, aphids, guava thrips, spiraling whitefly and guava scale. Insect pests populations on guava tree were counted every 15 days period before and after flowering and fruiting stages. The most significant finding in this study was the higher level of fruit fly damage that was severe in all selected sites tracked by mealy bugs, mites, stinkbug, red-banded thrips, guava moth, guava whitefly and scale in that order. This study suggested that the occurrence of significant population of fruit flies/tree (10.33) might be an indicator of potential source of infestations.

Ranjitha and Shashidhar (2006a) studied the population dynamics of fruit flies in mango orchard and observed the population of *B. correcta* which was 9.94 fruit flies/trap/week during 27th standard meteorological week, first reached a small peak of 92.82 fruit flies during 29th week. The population was declined and remained at low level till 38th week. From 39th standard week, the population increased rapidly and reached at major peak of 341.53 fruit flies during 45th standard meteorological week.

Rajitha and Shashidhar (2006b) studied the monitoring of fruit flies in guava orchard. They observed that occurrence of *Bactrocera dorsalis, B. correcta and B. zonata* throughout the year in guava, at Dharwad. Peak catch of *B. dosalis* was observed during 30th standard week (27.16 fruit flies) in 2003, and also a small peak during 1st standard week (2.03 fruit flies) in 2004.

Khan *et al.* (2007) reported the composition of fruit flies species *B. dorsalis* on apple (33.96 per cent), *C. incompleta* on ber (51.91 per cent), *B. zonata* on guava (49.62 per cent) and mango (74.66 per cent) in Pakistan. They observed maximum infestation 10.76 and 14.74 per cent, during August and September month, respectively.

Kundu (2007) studied the effect of different plant densities, *viz.*, 278 (6 x 6 m), 625 (4 x 4 m), 1111 (3 x 3m) and 1600 (2.5 x 2.5 m) plants per hectare in guava "L-49" studied in West Bengal. It is revealed that the increase in plant density markedly increased the plant height while decreasing the basal girth of the plant and spread of the crown. An increase in plant density from 278 to 1600/ha was decreased the yield from 36.8 kg to 27.9 kg/plant, reduced the fruit weight from 135.4 g to 125.7 g, but increased the yield per hectare from 102.4 to 446.5 q/ha. Closed planting decreased the TSS: acid ratio of fruit.

Masarrat (2007) studied the current status of insect pest problem in guava, the results indicates that, fruit borer incidence from 2.5 to 22.5% with crop loss range from 5% to 35%, fruit fly infestation ranged from 20-46% with 16 to 40 % crop losses.

Singh *et al.* (2007) studied the insect pest on guava, and observed the incidence of anar butterfly in guava 2.5 to 22.5%, castor capsule borer in the range from 7.79 to 25.2% and fruit fly ranged from 20.0 to 46 % respectively.

Baskaran *et al.* (2009) studied the population fluctuation of guava aphid, *Aphis gossypii* and its predator and observed the activity of aphid was high in first week of June.

Banjo (2010) studied the *Aleurodicus dispersus* in Nigeria. He observed that rainfall and temperature play a prominent role on the abundance and seasonal fluctuation of the insect and infestation, regulating their population. Moderate rainfall combined with high day temperature which usually occurs between April and May, following the onset of rain after the dry months (December and January) in Nigeria and other tropical regions favours high population of the spiraling whiteflies.

Baker *et al.* (2012) studied the scale infestation on guava trees and control measure of *Pulvinaria psidii.* The results indicates that, the highest population occurrence during spring season then autumn season. Whereas, min. temperature, max. temperature were favourable and R.H.% was slightly high.

Sunita (2012) studied the intensity of anar butterfly, *Virachola isocrates* with period and crop means. The results revealed that, among 40 periods of population of *V. isocrates* was highest in the 3rd of September.

Muhammad *et al.* (2014) studied the surveillance, population dynamics and fruits infestation of tephritid fruit flies in guava. The results indicated that tephritid fruit fly *B. zonata* was the predominant species at experimental site. Surveillance of fruit fly population in guava orchard revealed that peak population of *B. zonata* (40-30 per trap per week) and fruit infestation (9.05-7.45%) were recorded in June to August.

Benjamin *et al.* (2014) studied seasonal phenology of *B. invadens* and *C. cosyra* in Northern Ghana and reported the widespread variability and abundance of fruit fly species in the ecology ensured year round breeding of *B. invadens* and *C. cosyra* with different seasonal population levels. Dynamics of emergence of the fruit flies fluctuated at various levels in response to availability of the host fruits and the influence of weather factors.

2.2 The correlation of major pests with abiotic factor in high density guava plantation.

Qureshi *et al.* (1974) revealed that B. *zonata* population was lowest in January-February and increased gradually to reach a peak in March-May in Pakistan. Further, the population declined in June to July and again increased in August reaching another peak in September.

Shukla and Prasad (1985) reported three distinct population peaks of *B. dorsalis* during, March-April, May-June and September-October at Hessaraghatta, Bangalore.

In Haryana, the trap catches were significant and positive correction with maximum and minimum temperature, day degree and maximum relative humidity. However, it was negative correction with minimum relative humidity. The maximum infestation of *B. zonata* was recorded in the orchards, when temperature and relative humidity were 26-30 ^{0}C and 70-75 per cent, respectively.

Rana *et al.* (1992) studied the population dyanamics of *B.* zonata and reported that the trap catches of fruit flies were significant and positively correlated with maximum and minimum temperature and maximum relative humidity. However, it was negatively correlated with minimum relative humidity. The maximum infestation of B. *zonata* was recorded in the orchards, when temperature and relative humidity were 26-30 °C and 70-75 per cent, respectively.

Ishitiaqe *et al.* (1999) reported that the population of *Bactrocera* spp. was at peak in the winter crop during September, while in December it was negligible.

Demissie and Dahiya (2000) studied the effect of environmental factors on the population of thrips *R. cruentatus* on guava. The mean temperature, mean relative humidity and sunshine contributed to increase of thrips population between 32.94% on Allahabad safeda to 52.73% on L-49. Among the 3 abiotic factors, only the mean temperature affected the thrips population significantly. Thus, for the preliminary prediction model for thrips population, only the mean temperature was used while working on simple regression coefficient on different varieties/hybrids. The data revealed that mean temperature affect thrips population by 52.35 %.

Dale (2002) reported the maximum activity of *Bactrocera* spp. in the month of September coinciding with fruiting season of guava whereas, lowest activity was found in the month of May. He was reported that the fruit fly population had significant positive correlation with minimum temperature, maximum and minimum humidity and rainy days, and negative correlation with maximum temperature, sunshine hours and rainfall. The population of *B. dorsalis* peaked during July 2003 to January 2004 and *B. correcta* population peaked during July to November in 2003, while no significant peak was recorded in the year 2004. The population of *B. zonata* peaked during

October, 2003 and March, 2004. Further more, traps catches of *B. dorsalis* showed highly significant positive association with minimum temperature and relative humidity (morning and evening) and significant negative correlation with maximum temperature

Aishwariyam *et al.* (2007) studied seasonal incidence of spiraling whitefly. The observations recorded from May 2004 to April 2005 showed that the incidence of spiraling whitefly was found to build up during April - May. The nymphal population was relatively low during June and first fortnight of July and it was found to fluctuate before attaining peak in first fortnight of November (72.43) and then slowly declined. It has been observed that the incidence of all the three stages of *A. dispersus* had significant positive correlation with maximum temperature and non- significant positive correlation with minimum temperature and non- significant negative correlation with morning and afternoon relative humidity.

Faiza *et al.* (2007) studied the seasonal abundance of tephritid fruit flies in Shendi Area, Sudan. The results showed that *B. invadens* has two peaks, in August and November. Species belonging to *Ceratitis* had one peak in August for *C. cosyra* and in November for *C. capitata.* The seasonal activity of fruit flies varies according to climatic factors and host range availability. Weather factors, especially relative humidity have significant contribution on fluctuation of fruit flies populations.

Hui and Jianhong (2007) studied the annual monitoring of the population dynamics of the oriental fruit fly *B. dorsalis* (Hendel) in Xishuangbanna, southern Yunnan, by using methyl eugenol baited traps and factors including temperature, rainfall and host species with respect to the population fluctuation were analyzed systematically. The results revealed that the *B. dorsalis* trap catches observed significant positive correlation with minimum temperature, rainfall and wind speed. Whereas, the non significant correlation with relative humidity.

Muhammad *et al.* (2008) evaluated the incidence and development of *Thrips tabaci* and *Tetranychus urticae* on field grown cotton. Incidence of pests is highly affected by weather factors like mean air temperature, relative humidity and rainfall. Correlations between average population counts of cotton thrips and weather factor, the results shows that temperature played a significant and positive role for thrips (r = 0.645).

Patel *et al.* (2009) studied the population dynamics of chilli thrips, *Scirtothrips dorsalis* in relation with weather parameters. Results revealed that the incidence of *S. dorsalis* on chilli crop commenced from first week of September and continued up to harvest of the crops, peak activity was recorded in November 4.99 to 5.54 thrips/leaf and February-March 5.29 to 7.38 thrips/leaf, respectively. Correlation coefficient values worked out for thrips incidence and weather parameters revealed that, significant positive relationship existed with bright sun shine hours and maximum temperature. Whereas, significant negative correlation with humidity.

Laskar and Hirak (2010) evaluated the effect of metrological factor on the population dynamics of melon fly *(Bactrocera cucurbitae)* in the foot hills of Himalaya. The result revealed that, daily catch of flies observed maximum in 25th standard week of 2006-07.

Mishra *et al.* (2012) studied the population dynamics of oriental fruit fly, in relation to abiotic factors. Correlation between *B. dorsalis* and weather parameters resulted in a non-significant correlation with maximum temperature. While, it showed positive significant correlation with minimum temperature,

Basavaraj *et al.* (2013) evaluated the effect of weather parameters on incidence of castor shoot and capsule borer *D. punctiferalis*. Castor shoot and capsule borer population was significantly negatively correlated (-0.80*) only with maximum temperature of same fortnight. The correlation of larval population with weather parameters of one fortnight before, was significantly positively correlated with morning relative humidity (0.60*) and evening relative humidity (0.75*). But correlation of larval population with any weather parameters of two fortnights before was non significant.

Boopathi *et al.* (2013) studied the influence of weather factors on the incidence of fruit flies in chilli. The studies clearly showed that minimum temperature (r = -0.546*) was found to be an important predictor of fruit fly catches, while the maximum temperature, relative humidity, rainfall and rainy days had non-significant correlation with trap catches of fruit flies.

3. MATERIAL AND METHODS

The present investigations on pests of guava were carried out with a view to study the population fluctuation of different pests in high density guava plantation and correlation of major pest with weather parameter.

Rahuri is situated in central dry region of Maharashtra between 19^0 24' latitude and 74^0 39' longitudes at 675 meters above mean sea level. The average rainfall is 660 mm confined to monsoon period from June to November with occasional showers in pre-monsoon month of April and May. Mean maximum temperature is more than 30^0C throughout the year except in December. The relative humidity is high during monsoon months from July to September and uniformly low during summer months from March to May. The meteorological parameters prevailed during the experimentation period are presented in appendices. The material used and methods employed for the investigations are presented in this chapter.

3.1 Experimental site

The experiments was conducted at the Instructional cum Research orchard of Department of Horticulture, MPKV, Rahuri, from July to October, 2014 (*Mrig bahar*). The details of material used and methods adopted during the course of investigations are described and presented here in detail.

3.2 Material.

3.2.1 Application of fertilizers

Recommended dose of fertilizers (780:1125:300 NPK g/plant) was applied to 6 x 6 plant spacing and (385:555:150

NPK g/plant) applied to other closer plant spacing in the experiment.

3.2.2 Intercultural operations

Weeding was carried out from time to time to remove weeds and improve soil aeration and also conserve soil moisture. In all three weeding were undertaken during the crop season.

3.2.3 Other materials

The experiments was conducted by using insect sweeping net, magnifying lens, hand lens, simple microscope, plastic bags, fertilizer, plastic container, pencil, note book and labels.

3.3 Experiment details

1	Year and season	:	2014 (*Mrig bahar)*
2	Crop and variety	:	Guava , Sardar (L-49)
3	Design	:	RBD
4	Replications	:	4 (four)
5	Treatments	:	5 (five)
6	Spacing	:	1.0 x 1.0 m,1.5 x 1.5 m, 2.0 x 1.5 m, 2.0 x 2.0 m, 6.0 x 6.0 m (standard)

3.4 Treatment details

Sr. No.	Treatment	Spacing (m)
1	T_1	1.0 x 1.0
2	T_2	1.5 x 1.5
3	T_3	2.0 x 1.5
4	T_4	2.0 x 2.0
5	T_5	6.0 x 6.0

3.5 Method of recording the observation

The observations on different pests were taken at weekly interval in high density guava plantation. Four plants were selected from each treatment for recording observations and marked with labels. The observations was recorded for fruit fly (*B. dorsalis),* fruit borer (*D. punctiferalis)* anar caterpillar (*Deudorix isocrates),* infestation and number of mealy bugs, spiraling whiteflies and thrips per three leaves was counted by using appropriate method of observation.

3.5.1 Fruit fly (*Bactrocera dorsalis*)

The fruit damage by fruit fly was calculated on per cent basis by counting total number of fruits and infested fruits by fruit flies per plant at each picking, finally percentage fruit damage was calculated.

Any fruit was considered damaged if fruit fly ovipuncture mark was evidence or if when fruits were fallen on ground before maturity by observing the oviposition puncture.

3.5. **Pomegranate butterfly** *(Deudorix isocrates)*

The observation were recorded on randomly selected four plants per treatment which were marked with tags. Damage to fruit was recorded by recording total number of fruits and number of infested fruits per plant. Caterpillar of *D. isocrates* was bore into fruit and feed on the developing seeds and tissues. These entry hole facilitates the attack of bacteria and fungi, causing ultimately rotting of the fruits (Sunita, 2012). The affected fruit was deformed at the point of entry. At the fruiting stage of crops larva shift from one fruit to another fruit were observed.

3.5.3 **Castor capsule borer** *(Dichocrosis punctiferalis)*

The fruits damage by castor capsule borer was calculated on per cent basis by counting total number of fruits and number of infested fruits per plant. Attack of this insect pest observed at early fruiting stage of guava, it can be distinguished from *V. isocrates* by larval faecal material which may be seen on exuding out of the borer hole at the basal end of the fruit and premature dried and black fruits bearing observed. The larvae feed on pulp and seed of fruits were premature dry and drop of fruits observed.

3.5.4 **Thrips** *(Selenothrips rubrocinctus)*

The thrip population was recorded early in the morning. The thrips count was taken from three leaves of plant canopy one from lower, middle and upper part of the four tagged plants. The population of thrips was recorded with help of magnifying lens (10 x) on the line of work carried out by Patel *et* *al.* (2009). The thrip population were counted at weekly interval for the period of July to October 2014.

3.5.5 Spiraling whitefly *(Aleurodicus dispersus)*

The observation was taken on four randomly selected plants per treatment and four twigs of selected plant were marked with tags. For recording the observation on three leaves from the top of twig were observed at weekly interval on the basis of method adopted by Rashid *et al.* (2003). The population of spiraling whitefly was recorded at weekly interval by observing three leaves from the top of the twigs of selected plant. The white waxy covered area indicates incidence of spiraling whiteflies.

3.5.6 Guava mealy bug

The observation were taken by calculating number of mealy bug per three leaves which was selected from top, middle and bottom of each plant. The single tender branch of four selected plants, was marked with tag for recording observations on population of mealy bug insect comprising of nymphs and adults throughout the experimental periods on the basis of method adopted by Mani *et al.* (1990). The leaves was observed under magnifying lens or simple microscope. The data on mealy bug population was statistically analyzed after square root transformation.

3.6 Meteorological data

The meteorological data on maximum temperature (T. max.), minimum temperature (T. min.), relative humidity during morning (RH I) and evening (RH II) hours, rainfall (mm), rainy days and bright sun shine (B.S.S.) at weekly interval of

Rahuri region were obtained from the Agriculture meteorological observatory located at the central campus, MPKV Rahuri.

3.7 Statistical analysis

Data on fruit infestation due to guava fruit fly, pomegranate butterfly, castor capsule borer and number of mealy bugs, spiraling whiteflies and thrips were transformed by using appropriate formulae and then subjected to statistical analysis for interpreting the results. In order to compare the treatment effects based on generated data of field experiments, the actual counts were subjected to transformation as per the recommended statistical methods (Panse and Sukhatme, 1985).

The data on infestation based on calculated percentage were transformed to arc sin values in respect to fruit fly and fruit borer infestation. The data on counts of no. mealy bugs, thrips, whiteflies, per leaves were converted to square root transformation ($\sqrt{\mathbf{n+0.5}}$) where 'n' is the mean value of actual count of concerned pest.

3.8 Correlation of major pests with abiotic factors.

Correlation co-efficient between weekly average of weather parameter and average number of insect recorded at weekly interval were worked out by the method of Snedecor and cochan (1967) to find out the influence of different abiotic factors on population of thrips, spiraling whiteflies, and mealy bugs and per cent infestation of fruits due to fruit flies, anar caterpillar and castor capsule borer. Critical difference for each weather parameter was work out at 5 per cent and 1 per cent level of significance so as to compare significance of various weather parameters with pests of guava.

4. RESULTS AND DISSCUSSION

The field experiment was undertaken with an object to study the status of different pests in high density guava plantation and study the correlation of abiotic factors with major pests of guava (*Psidium guajava*). The experiment conducted at the Instructional cum Research orchard of Department of Horticulture, MPKV, Rahuri from July to October, 2014 (*Mrig bahar*). The results of the experiment are presented and discussed in this chapter.

4.1 The status of different pests in high density guava plantation

During the course of the present investigations, five plant spacing of guava were screened for their reaction to fruit fly (*Bactrocera dorsalis),* anar butterfly *(Deudorix isocrates),* fruit borer *(Dichocrosis punctiferalis)*, guava thrips *(Selenothrips rubrocinctus)*, spiraling whitefly *(Aleurodicus disperses)* and mealy bugs. The observations on the infestation of these pests were recorded at weekly interval from 27th to 44th standard meteorological week, for each plant spacing.

4.1.1 Effect of plant spacing on infestation of fruitflies, *B. dorsalis*

The observations on infestation of fruit flies were recorded separately at weekly interval from each plant spacing of high density meadow guava orchard by counting healthy and infested fruits. The per cent infestation of fruit flies was calculated and presented in Table 1 to 4 and graphically depicted in Fig. 1.

Table 1. Effect of plant spacing on infestation of guava fruit fly

Sr. No.	Treatment (spacing), M	Per cent infested fruits by fruit fly/plant (July)					
		1st week	2st week	3rd week	4th week	5th week	Average
1	1.0 x 1.0	8.13 (16.53)	10.25 (18.61)	9.00 (17.33)	10.75 (19.10)	10.60 (18.99)	9.70 (18.12)
2	1.5 x 1.5	6.75 (15.06)	7.00 (15.22)	8.25 (16.50)	8.50 (16.77)	9.63 (17.93)	8.01 (16.40)
3	2.0 x 1.5	5.60 (13.65)	6.50 (14.53)	6.88 (15.12)	6.38 (14.56)	6.70 (14.91)	6.40 (14.64)
4	2.0 x 2.0	5.48 (13.51)	4.25 (11.84)	3.50 (10.18)	4.28 (11.89)	5.75 (13.71)	4.73 (12.52)
5	6.0 x 6.0 (control)	3.73 (11.05)	2.95 (9.83)	3.13 (10.18)	3.88 (11.30)	4.38 (12.04)	3.64 (10.98)
SEm±		0.60	1.11	0.97	0.91	0.98	0.48
C.D. at 5%		1.87	3.44	3.00	2.81	3.03	1.46

* Figures in parentheses indicates arc sin transformed values

Table 2. Effect of plant spacing on infestation of guava fruit fly

Sr. No.	Treatment (spacing),m	Per cent infested fruits by fruit fly/plant (August)				
		1st week	2st week	3rd week	4th week	Average
1	1.0 x 1.0	10.25 (18.56)	11.00 (19.34)	10.18 (18.56)	8.05 (16.47)	9.84 (18.25)
2	1.5 x 1.5	8.25 (16.59)	9.70 (17.97)	8.05 (16.35)	6.63 (14.77)	8.06 (16.45)
3	2.0 x 1.5	6.50 (14.74)	6.55 (14.68)	6.73 (15.00)	5.75 (13.80)	5.75 (13.84)
4	2.0 x 2.0	5.63 (13.67)	6.25 (14.40)	7.00 (15.28)	5.20 (13.16)	6.00 (14.16)
5	6.0 x 6.0 (control)	4.88 (12.75)	4.75 (12.50)	5.40 (13.37)	3.43 (10.65)	4.58 (12.31)
	SEm±	0.77	1.08	0.94	0.75	0.44
	C.D. at 5%	2.38	3.33	2.89	2.32	1.20

*Figures in parentheses indicates arc sin transformed values

It could be seen from the Table 1 that, amongst the five different plant spacing, the 1.0 x 1.0 m recorded significantly maximum (8.13%) per cent infestation by fruit fly. However, it was at par with 1.5 x 1.5 m (6.75%) plant spacing. The plant spacing 6.0 x 6.0 m was registered lowest (3.73%) infestation in 1st week of July.

During the 4th week of July, the treatment with 1.0 x 1.0 m plant spacing was recorded maximum (10.75%) fruit fly infestation and it was at par with 1.5 x 1.5 m (8.50%) plant spacing. The significantly lowest (3.88%) infestation of fruit fly was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m plant spacing with infestation of 4.28 per cent.

The data presented in the Table 2 showed that the peak infestation of fruit fly was observed during 2nd week of August. The significantly lowest (4.75%) infestation of fruit fly was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m and 2.0 x 1.5 m plant spacing with infestation of 6.25 and 6.55%, respectively. The treatment with 1.0 x 1.0 m plant spacing was recorded maximum (11.00%) fruit fly infestation and it was at par with 1.5 x 1.5 m (9.70%) plant spacing.

During the 4th week of August significantly maximum (8.05%) fruit infestation was reported in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m (6.63%) plant spacing. Whereas, lowest (3.43%) infestation was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m and 2.0 x 1.5 m plant spacing with infestation of 5.20 and 5.75%, respectively.

It could be seen from the Table 3 that, amongst the

Table 3. Effect of plant spacing on infestation of guava fruit fly

Sr. No.	Treatment (spacing), m	Per cent infested fruits by fruit fly/plant (September)					
		1st week	2nd week	3rd week	4th week	5th week	Average
1	1.0 x 1.0	9.08 (17.48)	8.05 (16.47)	6.73 (15.00)	6.74 (14.88)	5.08 (12.98)	7.13 (15.40)
2	1.5 x 1.5	6.61 (14.87)	6.63 (14.77)	5.08 (12.98)	5.90 (14.02)	4.13 (11.70)	5.35 (13.34)
3	2.0 x 1.5	6.18 (14.35)	5.75 (13.80)	4.35 (12.02)	5.14 (13.07)	3.40 (10.57)	4.60 (12.32)
4	2.0 x 2.0	5.75 (13.80)	5.20 (13.16)	4.03 (11.56)	5.00 (12.90)	3.53 (10.77)	4.92 (12.73)
5	6.0 x 6.0 (control)	4.98 (12.67)	3.43 (10.65)	3.05 (10.03)	3.43 (10.61)	2.44 (8.94)	3.41 (10.55)
	SEm±	0.72	0.75	0.57	0.79	0.55	0.52
	C.D. at 5%	2.23	2.32	1.76	2.46	1.72	1.61

* Figures in parentheses indicates arc sin transformed values.

Table 4. Effect of plant spacing on infestation of guava fruit fly

Sr. No.	**Treatment (spacing) m**	**Per cent infested fruits by fruit fly/plant (October)**				
		1st Week	2nd Week	3rd Week	4th Week	Average
1	1.0 x 1.0	4.95 (12.82)	5.58 (13.53)	4.48 (12.20)	4.15 (11.68)	4.73 (12.54)
2	1.5 x 1.5	4.00 (11.48)	4.08 (11.60)	3.03 (9.95)	3.45 (10.68)	3.60 (10.92)
3	2.0 x 1.5	2.90 (9.72)	3.13 (10.03)	3.55 (10.71)	2.48 (9.01)	2.98 (9.91)
4	2.0 x 2.0	3.19 (10.27)	3.05 (10.03)	2.55 (9.15)	2.33 (8.74)	2.75 (9.53)
5	6.0 x 6.0 (control)	2.45 (8.99)	2.35 (8.82)	2.15 (8.43)	2.55 (9.18)	2.33 (8.77)
SEm±		0.49	0.70	0.60	0.52	0.29
C.D. at 5%		1.52	2.18	1.85	1.61	0.90

* Figures in parentheses indicates arc sin transformed values

five different plant spacing, the 1.0 x 1.0 m plant spacing were recorded maximum fruit fly infestation (9.08%) in the 1st week of September. Whereas, the significantly lowest (4.98%) infestation was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m and 2.0 x 1.5 m 1.5 x 1.5 m plant spacing with infestation of 5.75, 6.18 and 6.61% respectively. At 5th week of September significantly lowest (2.44%) infestation was recorded in 6.0 x 6.0 m plant spacing. However, it was at par with 2.0 x 2.0 m plant spacing (3.53%). The plant spacing 1.0 x 1.0 m was registered maximum infestation (5.08%) and it was at par with 1.5 x 1.5 m (4.13%) plant spacing.

Table 5. Monthly average infestation of fruit fly in high density guava in *Mrig bahar*

Sr. no.	Treatment (spacing), m	Per cent infested fruits by fruit fly /plant				
		July	August	September	October	Season average
1	1 x 1	9.70 (18.12)	9.84 (18.25)	7.13 (15.40)	4.73 (12.54)	7.85 (16.27)
2	1.5 x 1.5	8.01 (16.40)	8.06 (16.45)	5.35 (13.34)	3.60 (10.92)	6.26 (14.48)
3	2.0 x 1.5	6.40 (14.64)	5.75 (13.84)	4.60 (12.32)	2.98 (9.91)	4.93 (12.82)
4	2.0 x 2.0	4.73 (12.52)	6.00 (14.16)	4.92 (12.73)	2.75 (9.53)	4.60 (12.38)
5	6.0 x 6.0 (control)	3.64 (10.98)	4.58 (12.31)	3.41 (10.55)	2.33 (8.77)	3.47 (10.74)
SEm±		0.48	0.44	0.52	0.29	0.39
C.D. at 5%		1.46	1.20	1.61	0.90	1.20

* Figures in parentheses indicates arc sin transformed value.

The results presented in table 4 showed that the infestation of fruit fly was reduced in the month of October, against July, August and September.

In the 2nd week of October among different plant spacing, the spacing with 1.0 x 1.0 m were registered significant maximum (5.58%) infested fruits and it was at with 1.5 x 1.5 m (4.08%) plant spacing. Whereas, least (2.35%) fruit infestation was reported in recommended plant spacing of 6.0 x 6.0 m and it was at par with 2.0 x 2.0 m (3.05%) and 2.0 x 1.5 m (3.13%) plant spacing. At 4th week of October the plant spacing with 1.0 x 1.0 m was recorded maximum fruit fly infestation (4.15%) and it was at par with 1.5 x 1.5 m (3.45%) plant spacing. Whereas, the significantly lowest (2.55%) infestation was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m and 2.0 x 1.5 m and 1.5 x 1.5 m plant spacing with infestation of 2.33, 2.48 and 3.45%, respectively.

It could be seen from the Table 5 that, among four months of experiment, the infestation of fruit flies maximum in the month of August followed by July, September and October. The infestation level was maximum (9.84%) in 1.0 x 1.0 m in the month of August. Whereas least infestation was recorded in 6.0 x 6.0 m plant spacing. The season average infestation of fruit fly was maximum (7.85%) recorded in 1.0 x 1.0 m plant spacing and it was followed by 1.5 x 1.5 m (6.26%) plant spacing. Whereas, the significantly lowest (3.47%) infestation was recorded in 6.0 x 6.0 m plant spacing and it was followed by 2.0 x 2.0 m (4.60%) plant spacing.

The result of present study are similar with Muhammad *et al.* (2014), as they recorded that peak population of *B. dorsalis* (30-40 fruit fly/trap/week) and fruit infestation (7.05-9.05%) were recorded from June to August. The fruit fly damage gradually decreased from June 8.05% to fall down of 2.76% in May.

The present finding are in agreement with the results reported by Rana *et al.* (1992), they recorded that the incidence of *B. zonata* ranged from 10-20% on different varieties of guava in the month of August in Hariyana.

Singh *et al.* (2007), evaluated that the infestation of fruit fly ranged from 20.0 to 46% with crop loss of 16 to 40 %. Sarwar *et al.* (2014), registered the high population frequency of *B. zonata* (116-300) captured per trap per week and 8.05-18.59% fruit infestation was recorded from June to August.

4.1.2 Effect of plant spacing on infestation guava fruit borer, *D. punctiferalis*

The observations on effect of plant spacing on infestation of castor capsule borer were recorded separately at weekly interval for the period from July to October 2014 and presented in Tables 6, 7, 8, and 9 and depicted in Fig. 2.

The data presented in Table 6 shows that out of five plant spacing, the infestation of fruit borer was maximum (9.05%) in 1.0 x 1.0 m plant spacing in the 1st week of July. However, it was at par with 1.5 x 1.5 m (7.65%) and 2.0 x 1.5 m (6.80%) plant spacing. Whereas, the 2.0 x 2.0 m plant spacing recorded significantly lowest 4.13% infestation and it was at par with 6.0 x 6.0 m (4.33%) plant spacing.

The infestation level of *D. punctiferalis* was at peak in 1st week of July and it decline in progressive weeks. The infestation level of *D. punctiferalis* was comparatively low in 5th week of July and it was maximum (5.30%) in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m (4.28) and 2.0 x 1.5 m (3.55%) plant spacing. Whereas, the significantly lowest (2.30%) infestation was recorded in 6.0 x 6.0 m plant spacing and it was at par with

Table 6. Effect of plant spacing on infestation of fruit borer *Dichocrosis Punctiferalis*

Sr. No.	Treatment (spacing), m	Per cent infested fruits by fruit borer *D. punctiferalis* /plant (July)					
		1st week	2nd week	3rd week	4th week	5th week	Average
1	1.0 x 1.0	9.05 (17.34)	8.9 (17.30)	7.45 (15.77)	5.78 (13.78)	5.30 (13.21)	7.34 (15.61)
2	1.5 x 1.5	7.65 (15.98)	6.68 (15.12)	5,33 (13.22)	4.55 (12.14)	4.28 (11.84)	5.71 (13.79)
3	2.0 x 1.5	6.80 (15.01)	5.65 (13.68)	5.08 (12.96)	3.23 (10.21)	3.55 (10.75)	4.90 (12.70)
4	2.0 x 2.0	4.13 (11.62)	4.53 (12.28)	3.75 (11.11)	3.38 (10.54)	2.68 (9.40)	3.73 (11.12)
5	6.0 x 6.0 (control)	4.33 (11.99)	4.24 (12.28)	3.50 (10.77)	2.68 (9.39)	2.30 (8.66)	3.72 (11.11)
	SEm±	1.16	0.70	0.70	0.92	0.85	0.41
	C.D. at 5%	3.57	2.16	2.15	2.83	2.63	1.28

* Figures in parentheses indicates arc sin transformed values

Table 7. Effect of plant spacing on infestation of fruit borer *Dichocrosis Punctiferalis*

Sr. No.	Treatment (spacing), m	Per cent infested fruits by fruit borer *D. punctiferalis* /plant (August)				
		1st Week	2nd Week	3rd Week	4th Week	Average
1	1.0 x 1.0	5.10 (12.89)	5.35 (13.17)	5.35 (13.17)	4.68 (12.34)	5.08 (13.01)
2	1.5 x 1.5	4.70 (12.34)	3.90 (11.24)	4.93 (12.69)	4.35 (11.94)	4.45 (12.17)
3	2.0 x 1.5	4.60 (12.18)	3.45 (10.55)	3.23 (10.26)	3.65 (10.97)	3.70 (11.06)
4	2.0 x 2.0	3.73 (10.89)	2.45 (8.87)	2.80 (9.54)	2.80 (9.54)	2.93 (9.82)
5	6.0 x 6.0 (control)	2.60 (9.25)	2.23 (8.52)	2.30 (8.72)	2.05 (8.21)	2.28 (8.67)
SEm±		0.77	0.81	1.01	0.88	0.27
C.D. at 5%		2.37	2.51	3.11	2.72	0.83

* Figures in parentheses indicates arc sin transformed values

2.0 x 2.0 m plant spacing with infestation of 2.68%.

It could be seen from the data presented in Table 7 that the significantly lowest infestation of 2.60% was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m (3.73%) plant spacing in the 1st week of August. Whereas, maximum infestation of 5.10% in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m and 2.0 x 1.5 m plant spacing with infestation of 4.70 and 4.60%, respectively. The infestation of castor capsule borer was maximum (5.35%) recorded in 1.0 x 1.0 m plant spacing in 3rd week of August and it was at par with 1.5 x 1.5 m (4.93%) and 2.0 x 1.5 m (3.23%) plant spacing. Whereas, the plant spacing with 6.0 x 6.0 m were recorded significantly lowest 2.30% infestation of castor capsule borer and it was at par with 2.0 x 2.0 m (2.80%) plant spacing.

The data presented in the Table 8 shows that the significantly lowest infestation of 2.00% was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m (2.45%), 2.0 x 1.5 m (3.35%) plant spacing in the 2nd week of September. Whereas, maximum infestation of 4.15% recorded in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m and 2.0 x 1.5 m plant spacing with infestation of 3.30 and 3.35%, respectively. At 5th week of September the 1.0 x 1.0 m plant spacing were recorded maximum (3.10%) fruit borer infestation and it was at par with 1.5 x 1.5 m (2.15%) plant spacing. Whereas, the significantly lowest (1.30%) infestation was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m and 2.0 x 1.5 m plant spacing with infestation of 1.85 and 2.08%, respectively. The infestation level was comparatively low in 5th week of September as compare to other weeks.

Table 8. Effect of plant spacing on infestation of fruit borer, *Dichocrosis Punctiferalis*

Sr. No.	Treatment (spacing), m	Per cent infected fruits by fruit borer *D. punctiferalis* /plant (September)					
		1st week	2nd week	3rd week	4th week	5th week	Average
1	1.0 x 1.0	3.55 (10.80)	4.15 (11.71)	4.03 (11.55)	3.35 (10.81)	3. 10 (10.07)	3.60 (10.92)
2	1.5 x 1.5	3.20 (10.18)	3.30 (10.28)	3.30 (10.28)	2.48 (8.80)	2.15 (8.32)	2.92 (9.83)
3	2.0 x 1.5	2.93 (9.74)	3.35 (10.43)	2.40 (8.80)	2.40 (8.80)	2.08 (8.22)	2.65 (9.31)
4	2.0 x 2.0	2.38 (9.74)	2.45 (8.87)	2.03 (8.07)	2.18 (8.34)	1.85 (7.76)	2.02 (8.11)
5	6.0 x 6.0 (control)	1.68 (7.41)	2.00 (8.87)	1.65 (7.27)	1.65 (7.27)	1.30 (6.55)	1.73 (7.56)
SEm±		0.66	0.78	0.63	0.68	0.58	0.40
C.D. at 5%		2.04	2.42	1.95	2.12	1.79	1.24

* Figures in parentheses indicates arc sin transformed values

It could be seen from the Table 9 that the infestation of the castor capsule borer was started to decline, from 1st week of October and it was 3.10% in 1.0 x 1.0 m and it was reduced to 2.13% in same spacing in 5th week of September.

The data from Table 6 to 9 shows that the infestation of fruit borer was peak during 1st week of July (9.05%) in 1.0 x 1.0 m plant spacing then started declined at 3rd week of July and the infestation of fruit borer suddenly declined up to 5.78% in 4th week of July. At 4th week of October it was reaches to 2.13% in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m (1.75%) plant spacing. Whereas, the lowest infestation (0.75%) was observed on 6.0 x 6.0 m, which was significantly least than all other plant spacing, except 2.0 x 2.0 m (0.90%) and 2.0 x 1.5 m (1.23).

The monthly average infestation of castor capsule borer was maximum (7.34%) in 1.0 x 1.0 m plant spacing and least (3.72%) in 6.0 x 6.0 m plant spacing observed in the month of July (Table 10). The monthly lowest (2.48% and 1.94%) average infestation were recorded in 1.0 x 1.0 m and 1.5 x 1.5 m plant spacing, respectively in the month of October. Whereas, the lowest infestation was recorded in 6.0 x 6.0 m (0.98%) and it was followed by 2.0 x 2.0 m (1.28%) plant spacing (Table 10).

It can be seen from the Table 10 that, the season average (four month) infestation of castor capsule borer was recorded maximum (4.63%) in 1.0 x 1.0 m plant spacing and it was followed by 1.5 x 1.5 m (3.76%), 2.0 x 1.5 m (3.19%) and 2.0 x 2.0 m (2.49%) plant spacing. Whereas, the significantly lowest (2.17%) infestation was recorded in 6.0 x 6.0 m plant spacing.

Table 9. Effect of plant spacing on infestation of fruit borer, *Dichocrosis Punctiferalis*

Sr. No.	Treatment (spacing), m	Per cent infested fruits by fruit borer *D. punctiferalis* /plant (October)				Average
		1st Week	2nd Week	3rd Week	4th Week	
1	1.0 x 1.0	3.10 (10.07)	2.50 (9.05)	2.25 (8.61)	2.13 (8.37)	2.48 (9.03)
2	1.5 x 1.5	2.23 (8.71)	1.83 (7.73)	2.00 (8.13)	1.75 (7.53)	1.94 (7.99)
3	2.0 x 1.5	2.08 (8.22)	1.48 (6.94)	1.48 (6.94)	1.23 (6.35)	1.52 (7.05)
4	2.0 x 2.0	1.85 (7.76)	1.38 (6.73)	1.10 (5.92)	0.90 (5.30)	1.28 (6.43)
5	6.0 x 6.0 (control)	1.23 (6.35)	1.15 (6.14)	0.95 (5.52)	0.75 (4.90)	0.98 (5.64)
SEm±		0.52	0.35	0.46	0.53	0.15
C.D. at 5%		1.61	1.10	1.41	1.63	0.45

* Figures in parentheses indicates arc sin transformed values.

Table 10. Average infestation of *Dichocrosis punctiferalis* in high density guava in *Mrig bahar*

Sr. no.	Treatment (spacing), m	Per cent infested fruits by *D. punctiferalis* per plant				
		July	August	September	October	Season average
1	1.0 x 1.0	7.34 (15.61)	5.08 (13.01)	3.60 (10.92)	2.48 (9.03)	4.63 (12.42)
2	1.5 x 1.5	5.72 (13.79)	4.45 (12.17)	2.92 (9.83)	1.94 (7.99)	3.76 (11.18)
3	2.0 x 1.5	4.90 (12.70)	3.70 (11.06)	2.65 (9.31)	1.52 (7.05)	3.19 (10.28)
4	2.0 x 2.0	3.73 (11.12)	2.93 (9.82)	2.02 (8.11)	1.28 (6.43)	2.49 (9.07)
5	6.0 x 6.0	3.72 (11.11)	2.28 (8.67)	1.73 (7.56)	0.98 (5.64)	2.17 (8.30)
	SEm±	0.41	0.27	0.40	0.15	0.19
	C.D. at 5%	1.28	0.83	1.24	0.45	0.58

* Figures in parentheses indicates arc sin transformed values

The perusal of literature on the effect of plant spacing on castor capsule borer infestation revealed that there is no evident of published on the castor capsule borer which were used in present study.

The results of similar study regarding castor capsule borer *D. punctiferalis* infestation was varies from 7.79 to 25.2% and higher incidence were recorded on Sardar, Arka Amulya and Sardar selection-4 which was low on Bangalore selection, Shilong-1 and red flesh (Singh *et al.* 2007).

Masarrat (2007), revealed that, castor capsule borer incidence was varies from 2.5 to 22.5% with crop loss ranged from 5 to 35%, fruit fly infestation ranged from 20-46% with 16 to 40 % crop losses in guava.

4.1.3 Effect of plant spacing on infestation of anar caterpillar, *D. isocrates*

It is evident from Table 11 that the infestation of anar caterpillar, *Deudorix isocrates* was noticed from 1st week of July (27th meteorological week) immediately after first shower of monsoon.

It is seen from the Table 11 that, among the five plant spacing, the 6.0 x 6.0 m plant spacing showed significantly lowest infestation (3.50%) in the 3rd week of July and it was at par with 2.0 x 2.0 m (3.38%), 2.0 x 1.5 m (4.78%) plant spacing. Whereas, maximum infestation 6.45% were observed in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m (5.40%) and 2.0 x 1.5 m plant spacing.

At the 1st week of July the lowest fruit infestation (2.55%) was recorded in 6.0 x 6.0 m and it was at par with 2.0 x 2.0 m, 2.0 x 1.5 m and 1.5 x 1.5 m plant spacing with fruit infestation of 3.25, 3.95 and 4.15 per cent. Whereas, maximum anar caterpillar infestation 5.78% were observed in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m (4.60%) and 2.0 x 1.5 m (3.95%) plant spacing.

The data presented in Table 12 and Fig. 3 opined that the infestation of anar caterpillar among eighteen experimental weeks, the highest infestation was recorded in the third week of August. At 3rd week of August highest infestation of anar caterpillar (7.79%) was recorded in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m (6.30%) plant spacing. Whereas, the 6.0 x 6.0 m plant spacing was recorded lowest fruit infestation (3.60%) and it was at par with 2.0 x 2.0 m plant spacing with fruit infestation of 4.50 per cent.

Table 11. Effect of plant spacing on infestation of anar caterpillar, *Deudorix isocrates*

Sr. No.	Treatment (spacing), m	Per cent infested fruits by anar caterpillar *(D. isocrates)* /plant (July)					
		1st week	2nd week	3rd week	4th week	5th week	Average
1	1.0 x 1.0 m	5.78 (13.78)	5.78 (13.78)	6.45 (14.71)	6.38 (14.62)	6.15 (14.18)	6.10 (14.29)
2	1.5 x 1.5 m	4.15 (11.62)	3.78 (11.06)	5.40 (13.34)	4.55 (12.14)	4.80 (12.60)	4.55 (12.27)
3	2.0 x 1.5 m	3.95 (11.37)	4.28 (11.91)	4.78 (12.29)	3.90 (11.21)	3.58 (10.86)	4.30 (11.96)
4	2.0 x 2.0 m	3.25 (10.36)	3.43 (10.64)	3.38 (10.54)	3.45 (1.73)	3.70 (11.07)	3.42 (10.65)
5	6.0 x 6.0 m (control)	2.55 (9.14)	2.75 (9.45)	3.50 (10.74)	2.63 (9.28)	2.60 (9.28)	2.80 (9.61)
SEm±		0.90	0.85	0.97	0.81	0.92	0.25
C.D. at 5%		2.79	2.63	2.99	2.51	2.84	0.78

* Figures in parentheses indicates arc sin transformed values

Table 12. Effect of plant spacing on infestation of anar caterpillar, *Deudorix isocrates*

Sr. No.	Treatment (spacing), m	Per cent infested fruits by anar caterpillar *(D. isocrates)* /plant (August)				
		1st Week	2nd Week	3rd Week	4th Week	Average
1	1.0 x 1.0	6.66 (14.78)	7.57 (15.89)	7.79 (16.16)	7.28 (15.56)	7.29 (15.66)
2	1.5 x 1.5	5.70 (13.76)	6.23 (14.49)	6.30 (14.53)	6.23 (14.49)	6.10 (14.33)
3	2.0 x 1.5	5.18 (13.76)	5.75 (13.81)	5.75 (13.81)	5.18 (13.10)	5.40 (13.43)
4	2.0 x 2.0	4.10 (11.64)	4.50 (12.21)	4.50 (12.21)	4.35 (12.00)	4.35 (12.04)
5	6.0 x 6.0 (control)	3.05 (9.85)	3.50 (10.78)	3.60 (10.93)	3.50 (10.78)	3.40 (10.62)
SEm±		0.95	0.64	0.58	0.64	0.24
C.D. at 5%		2.95	1.99	1.81	2.00	0.73

* Figures in parentheses indicates arc sin transformed values

During 1st week of August the anar caterpillar maximum infestation of 6.66% were observed in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m (5.70%) and 2 0 x 1.5 m (5.18%) plant spacing. Whereas, the 6.0 x 6.0 m plant spacing showed significantly lowest average infestation (3.05%) and it was par with 2.0 x 2.0 m (4.10%) plant spacing.

It could be seen from the Table 13 that the lowest fruit infestation (3.40%) was recorded in 6.0 x 6.0 m and it was at par with 2.0 x 2.0 m (4.20%) plant spacing. Whereas, the maximum anar caterpillar infestation of 6.78% was observed in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m (6.16%) plant spacing during 1st week of September. At the 5th week of September the maximum anar caterpillar infestation of 5.56% were observed in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m (4.98%) plant spacing. Whereas, significantly lowest infestation (2.38%) were observed in 6.0 x 6.0 and it was followed by 2.0 x 2.0 m (3.30%).

It could be seen from the Table 14 that among the five different plant spacing, the 6.0 x 6.0 m plant spacing showed significantly lowest average infestation (2.10%) and it was par with 2.0 x 2.0 m (2.85%) plant spacing in the 2nd week of October. Whereas, maximum infestation of 5.00% were observed in 1.0 x 1.0 m and it was at par with 1.5 x 1.5 m (4.28%) plant spacing.

The monthly av. infestation of anar caterpillar was maximum (7.29%) in the month of August in 1.0 x 1.0 m plant spacing and least (3.40%) in 6.0 x 6.0 m plant spacing and it was followed by 2.0 x 2.0 m (4.35 %) plant spacing (Table 15 and Fig. 3).

Table 13. Effect of plant spacing on infestation of anar caterpillar, *Deudorix isocrates*

Sr. No.	Treatment (spacing), m	Per cent infested fruits by anar caterpillar (*D. isocrates*) /plant (September)					
		1st week	2nd week	3rd week	4th week	5th week	Average
1	1.0 x 1.0	6.78 (15.01)	6.28 (14.48)	6.13 (14.31)	5.98 (14.13)	5. 56 (13.73)	6.1 (14.29)
2	1.5 x 1.5	6.16 (14.40)	5.79 (13.90)	5.73 (13.85)	5.35 (13.34)	4.98 (12.86)	5.42 (13.44)
3	2.0 x 1.5	4.78 (12.65)	4.60 (12.38)	4.53 (12.28)	4.38 (12.07)	4.30 (11.97)	4.50 (12.23)
4	2.0 x 2.0	4.20 (11.80)	3.80 (11.20)	3.73 (11.11)	3.48 (10.73)	3.30 (10.47)	3.62 (10.95)
5	6.0 x 6.0 (control)	3.40 (10.63)	3.15 (10.20)	2.90 (9.77)	2.90 (9.77)	2.38 (8.75)	2.93 (9.48)
SEm±		0.51	0.42	0.40	0.43	0.49	0.28
C.D. at 5%		1.59	1.32	1.25	1.33	1.51	0.85

* Figures in parentheses indicates arc sin transformed values

Table 14. Effect of plant spacing on infestation of anar caterpillar, *Deudorix isocrates*

Sr. No.	Treatment (spacing), m	Per cent infested fruits by anar caterpillar, *D. isocrates* /plant (October)				
		1st Week	2nd Week	3rd Week	4th Week	Average
1	1.0 x 1.0	5.33 (13.32)	5.00 (12.92)	4.45 (12.17)	3.95 (11.43)	4.68 (12.47)
2	1.5 x 1.5	4.60 (12.38)	4.28 (11.91)	3.63 (10.95)	3.08 (10.08)	3.89 (11.34)
3	2.0 x 1.5	4.05 (11.59)	3.58 (10.83)	3.15 (10.17)	2.63 (9.31)	3.32 (10.47)
4	2.0 x 2.0	3.08 (10.08)	2.85 (9.69)	2.63 (9.31)	2.13 (8.32)	2.64 (9.33)
5	6.0 x 6.0 (control)	2.10 (8.16)	2.10 (8.16)	1.80 (7.54)	1.58 (7.14)	1.90 (7.90)
SEm±		0.46	0.57	0.63	0.50	0.11
C.D. at 5%		1.42	1.77	1.95	1.54	0.35

* Figures in parentheses indicates arc sin transformed values

Table 15. Average infestation of anar caterpillar in high density guava *mrig bahar*

Sr. no.	Treatment (spacing) M	Per cent infested fruits by *D. isocrates* per plant				
		July	August	September	October	Season average
1	1.0 x 1.0	6.10 (14.29)	7.29 (15.66)	6.10 (14.29)	4.68 (12.47)	6.04 (14.22)
2	1.5 x 1.5	4.55 (12.60)	6.10 (14.33)	4.42 (13.34)	3.89 (11.34)	4.74 (12.58)
3	2.0 x 1.5	4.30 (11.96)	5.40 (13.43)	4.50 (12.23)	3.32 (10.47)	4.38 (12.08)
4	2.0 x 2.0	3.42 (10.65)	4.35 (12.04)	3.62 (10.95)	2.64 (9.33)	3.51 (10.79)
5	6.0 x 6.0 (control)	2.80 (9.61)	3.40 (10.62)	2.93 (9.48)	1.90 (7.90)	2.76 (9.56)
SE±		0.25	0.24	0.28	0.11	0.08
C.D. at 5%		0.78	0.73	0.85	0.35	0.26

* Figures in parentheses indicates arc sin transformed values

The season average (four month) infestation of anar caterpillar was maximum (6.04%) recorded in 1.0 x 1.0 m plant spacing and it was followed by 1.5 x 1.5 m (4.74%) plant spacing. Whereas, the significantly lowest (2.76%) infestation observed in 6.0 x 6.0 m plant spacing.

The present finding are in agreement with the results reported by Sunita (2012), she revealed that the population of *D. isocrates* was found the highest in 3rd week of September and followed by 3rd week of July and 2nd week of September and further also observed that maximum population on Apple colour, followed by Allahabad safeda and red flesh in guava genotypes.

The present finding are partly match with Singh *et al.* (2007), as they recorded that the incidence of *D. isocrates* was peak in the month of August and 2nd peak during November to December. Average fruit loss varies from 11.09 to 13.88% in L-

49 and 20.69 to 21.38% in Allahabad safeda, respectively. Masarrat (2007) revealed that, the fruit borer incidence was varies from 2.5 to 22.5% with crop loss ranged from 5 to 35%, fruit fly infestation ranged from 20-46% with 16 to 40 % crop losses in guava.

4.1.4 Effect of plant spacing on incidence of guava thrips, *S. rubrocinctus*

The perusal of data presented in Table 16 and Fig. 4 revealed that the infestation of thrips ranging from 0.8 to 1.38 thrips per leaf noticed on different plant spacing in the 27th meteorological week. The significantly maximum population of thrips (1.53 per leaf) observed on 1.0 x 1.0 m plant spacing, in 28th meteorological week and it was at par with 1.5 x 1.5 m plant spacing (1.23 thrips/leaf). Whereas, treatment 6.0 x 6.0 m plant spacing observed significantly the lowest (0.80 thrips/leaf) and it was at par with 2.0 x 2.0 m (1.00 thrips/leaf) plant spacing.

At 38th meteorological week, almost all the plant spacing observed highest thrips population as compared to earlier observation and the significantly maximum population of 1.73 thrips per leaf was observed in the 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m (1.45 thrips/leaf) plant spacing. Whereas, significantly minimum thrips population was recorded on 6.0 x 6.0 m plant spacing (0.83 thrips /leaf). It was however, at par with 2.0 x 2.0 m plant spacing (0.90 thrips /leaf).

The result of present study are partly similar to those of Muhammad Sarwar (2006), as he revealed that the 5.33 thrips per trees were observed throughout the year on guava.

Table 16 : Effect of plant spacing on incidence of thrips

Sr. no.	Treatment (spacing), m / Met. Week	No. of thrips per leaf					SEm ±	C.D. at 5%
		T_1 1.0x1.0 m	T_2 1.5x1.5 m	T_3 2.0x1.5 m	T_4 2.0x2.0 m	T_5 6.0x6.0 M		
1	27	1.38 (1.37)	1.00 (1.22)	0.90 (1.18)	0.80 (1.14)	0.80 (1.14)	0.04	0.12
2	28	1.53 (1.42)	1.23 (1.31)	1.15 (1.28)	1.00 (1.22)	0.80 (1.14)	0.03	0.11
3	29	1.45 (1.39)	1.30 (1.34)	1.15 (1.28)	1.00 (1.22)	0.73 (1.10)	0.05	0.17
4	30	1.23 (1.31)	1.08 (1.25)	1.00 (1.22)	0.80 (1.14)	0.70 (1.09)	0.03	0.12
5	31	0.80 (1.14)	0.63 (1.06)	0.53 (1.01)	0.53 (1.01)	0.30 (0.89)	0.04	0.13
6	32	0.60 (1.05)	0.45 (0.97)	0.43 (0.93)	0.30 (0.89)	0.23 (0.85)	0.03	0.11
7	33	0.60 (1.05)	0.45 (0.97)	0.40 (0.95)	0.38 (0.93)	0.23 (0.85)	0.03	0.10
8	34	0.70 (1.09)	0.50 (1.00)	0.43 (0.96)	0.38 (0.93)	0.30 (0.89)	0.03	0.45
9	35	0.98 (1.21)	0.70 (1.09)	0.63 (1.05)	0.45 (0.97)	0.45 (0.97)	0.05	0.15
10	36	1.08 (1.25)	0.80 (1.14)	0.70 (1.09)	0.63 (1.05)	0.53 (1.01)	0.04	0.13
11	37	1.38 (1.37)	1.08 (1.25)	0.78 (1.22)	0.75 (1.12)	0.80 (10.9)	0.04	0.14
12	38	1.73 (1.49)	1.45 (1.40)	1.20 (1.30)	0.90 (1.18)	0.83 (1.14)	0.05	0.15
13	39	1.00 (1.22)	0.53 (1.01)	0.45 (0.97)	0.38 (0.93)	0.23 (0.85)	0.04	0.17
14	40	0.45 (0.97)	0.23 (0.85))	0.26 (0.87)	0.15 (0.80)	0.08 (0.76)	0.03	0.11
15	41	0.45 (0.97)	0.30 (0.89)	0.26 (0.87)	0.19 (0.83)	0.11 (0.78)	0.03	0.11
16	42	0.43 (0.96)	0.30 (0.89)	0.26 (0.87)	0.19 (0.83)	0.10 (0.77)	0.03	0.10
17	43	0.35 (0.92)	0.25 (0.86)	0.23 (0.85)	0.15 (0.80)	0.08 (0.75)	0.03	0.09
18	44	0.35 (0.92)	0.15 (0.80)	0.13 (0.79)	0.11 (0.78)	0.00 (0.71)	0.03	0.12

*Figures in parentheses indicates $\sqrt{\mathbf{n + 0.5}}$ transformation

Singh *et al.* (2007), evaluated that the thrips population was found low during January month but peak activity recorded during April. The mean temperature were significantly affects the population of this pest on guava. Red banned thrips was attack fruits during the November month of winter at fruit setting to harvesting month of April (Demissie and Dahiya, 2000). The thrips population recorded during investigation periods was low as compared the population recorded by earlier workers.

4.1.5 Effect of plant spacing on incidence Spiraling whitefly, *A. dispersus*

The perusal data presented in Table 17 revealed that the incidence of spiraling whitefly ranging from 0.10 to 2.53 whiteflies per leaf was noticed on the 1.0 x 1.0 m plant spacing.

First incidence of spiraling whiteflies was noticed in 30th M.W. (4th week of July) and the population was at peak in last week of October (44th M.W.) ranged from 1.73 to 2.53 whiteflies per leaf in all plant spacing. When maximum and minimum temperature was 32 and 14.0^{0}C, morning and evening relative humidity was 56 and 36%, respectively.

At 44th meteorological week the significantly maximum population of 2.53 spiraling whiteflies per leaf was recorded on 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m (2.23 whiteflies/leaf) Plant spacing. However, significantly least incidence (1.73 whiteflies/leaf) was recorded on 6.0 x 6.0 m plant spacing and it was par with 2.0 x 2.0 m (2.08 whiteflies/ leaf) plant spacing.

Table 17 : Effect of plant spacing on incidence of spiraling whitefly

Sr. no	Treatment (spacing), m / Met. Week	No. of spiraling whitefly per leaves					SEm ±	C.D. at 5%
		T_1 1.0x1.0m	T_2 1.5x1.5 m	T_3 2.0x1.5 m	T_4 2.0x2.0 m	T_5 6.0x6.0 m		
1	30	0.10 (0.77)	0.23 (0.85)	0.15 (0.86)	0.00 (0.71)	0.00 (0.71)	0.03	0.11
2	31	0.23 (0.85)	0.30 (0.89)	0.23 (0.85)	0.19 (0.83)	0.00 (0.71)	0.03	0.11
3	32	0.30 (0.89)	0.30 (0.89)	0.23 (0.85)	0.19 (0.83)	0.00 (0.71)	0.02	0.08
4	33	0.45 (0.97)	0.43 (0.96)	0.30 (0.89)	0.23 (0.85)	0.00 (0.71)	0.03	0.11
5	34	0.53 (1.01)	0.45 (0.97)	0.30 (0.89)	0.23 (0.85)	0.23 (0.85)	0.03	0.11
6	35	0.53 (1.01)	0.45 (0.97)	0.38 (0.93)	0.30 (0.89)	0.16 (0.81)	0.03	0.11
7	36	0.80 (1.14)	0.60 (1.05)	0.45 (0.97)	0.45 (0.97)	0.30 (0.89)	0.03	0.11
8	37	0.80 (1.14)	0.60 (1.05)	0.45 (0.97)	0.45 (0.97)	0.30 (0.98)	0.03	0.11
9	38	0.98 (1.21)	0.70 (1.09)	0.63 (1.05)	0.45 (0.97)	0.38 (0.93)	0.05	0.16
10	39	1.15 (1.28)	0.88 (1.17))	0.60 (1.05)	0.80 (1.14)	0.55 (1.02)	0.05	0.16
11	40	1.30 (1.34)	1.00 (1.22)	0.90 (1.18)	0.80 (1.14)	0.73 (1.10)	0.44	0.15
12	41	1.45 (1.40)	1.23 (1.31)	1.15 (1.28)	0.90 (1.18)	0.88 (1.17)	0.04	0.14
13	42	1.80 (1.52)	1.70 (1.48)	1.63 (146)	1.45 (1.40)	1.13 (1.27)	0.05	0.15
14	43	2.38 (1.69)	1.90 (1.55)	1.80 (1.52)	1.63 (1.45)	1.45 (1.40)	0.04	0.12
15	44	2.53 (1.73)	2.23 (1.65)	2.15 (1.63)	2.08 (1.60)	1.73 (1.49)	0.04	0.12

*Figures in parentheses indicates $\overline{\mathbf{n+0.5}}$ transformation

The population density of spiraling whitefly was maximum found in ultra high density plantation as compared to wider plant spacing (6.0 x 6.0 m).

The present finding are in agreement with the results reported by Rashid *et al.* (2003) as they studied for twelve month experimental periods and reported that there was major peak period of whitefly infestation in December to February. In the month of September whitefly started eggs laying on the underside of top leaf, when mean percentage of adult whiteflies per twig was low (0.34± 0.05) and increase to maximum in January.

Singh *et al.* (2007), reported that the whitefly was found throughout the year on guava in Bangalore with high population in summer (March-June) and low in winter (October-January). Muhammad Sarwar (2006), result revealed that the 3.33 mean population of whitefly per tree was observed throughout the year on guava.

4.1.6 Effect of plant spacing on incidence of guava mealy bugs

The observations on the nymph and adult population of mealy bug was recorded at weekly interval starting from 30th to 44th meteorological week, and presented in Table 18 and depicted in Fig. 6.

It could be seen from the data the infestation of guava mealy bug was negligible in the 30th meteorological week.

At the 35th meteorological week no plant was found to be free from mealy bug infestation and average pest population was found to be vary from 0.23 to 0.63 mealy bug/leaf on different plant spacing.

Table 18 : Effect of plant spacing on incidence of mealy bugs

Sr. No.	Treatment (spacing) / Met. Week	No. of mealy bug per leaf					SE±	C.D. at 5%
		T_1 1.0x1.0 m	T_2 1.5x1.5 m	T_3 2.0x1.5 m	T_4 2.0x2.0 m	T_5 6.0x6.0 m		
1	30	0.20 (0.84)	0.15 (0.80)	0.06 (0.75)	0.05 (0.74)	0.00 (0.71)	0.02	0.07
2	31	0.23 (0.85)	0.10 (0.77)	0.05 (0.74)	0.03 (0.72)	0.00 (0.71)	0.02	0.09
3	32	0.38 (0.93)	0.23 (0.85)	0.11 (0.78)	0.08 (0.75)	0.00 (0.71)	0.03	0.11
4	33	0.38 (0.93)	0.23 (0.85)	0.15 (0.80)	0.11 (0.78)	0.00 (0.71)	0.04	0.14
5	34	0.45 (0.97)	0.30 (0.89)	0.23 (0.85)	0.15 (0.80)	0.00 (0.71)	0.04	0.12
6	35	0.63 (1.05)	0.53 (1.01)	0.30 (0.8)	0.23 (0.85)	0.23 (0.85)	0.04	0.13
7	36	0.63 (1.05)	0.38 (0.93)	0.33 (0.90)	0.23 (0.85)	0.15 (0.80)	0.04	0.14
8	37	0.63 (1.05)	0.38 (0.93)	0.30 (0.89)	0.30 (0.89)	0.23 (0.85)	0.03	0.11
9	38	0.88 (1.17)	0.63 (1.05)	0.45 (0.97)	0.38 (0.93)	0.23 (0.85)	0.05	0.15
10	39	0.98 (1.21)	0.55 (1.02)	0.48 (0.97)	0.55 (1.02)	0.45 (0.97)	0.05	0.16
11	40	0.98 (1.21)	0.70 (1.09)	0.53 (1.01)	0.45 (0.97)	0.35 (0.92)	0.04	0.13
12	41	1.30 (1.34)	1.05 (1.24)	0.80 (1.14)	0.63 (1.05)	0.55 (1.02)	0.04	0.15
13	42	1.45 (1.40)	1.23 (1.31)	1.13 (1.27)	1.00 (1.22)	0.80 (1.14)	0.03	0.10
14	43	1.80 (1.52)	1.48 (1.40)	1.55 (1.43)	1.15 (1.28)	1.15 (1.28)	0.05	0.16
15	44	2.38 (1.70)	2.15 (1.63)	1.88 (1.54)	1.73 (1.49)	1.48 (1.40)	0.04	0.15

* Figures in parentheses indicates $\sqrt{n + 0.5}$ transformation

The highest average population of (2.38 mealy bug per leaf) was recorded at the 44th meteorological week in 1.0 x 1.0 m plant spacing, and it was at par with 1.5 x 1.5 m (2.15 mealy bug/leaf) plant spacing. Whereas, the lowest average population of mealy bug (1.48 per leaf) in 6.0 x 6.0 m, it was remained at par with 2.0 x 2.0 m(1.72 mealy bug/leaf) and 2.0 x 1.5 m (1.88 mealy bug/leaf) plant spacing. During 44th M.W. the maximum and minimum temperature were 32.^{0}C and 14.0^{0}C, respectively and R.H. at morning and evening were 56 and 36 per cent, respectively.

Further it was observed that, from 33rd M.W., almost in all the plant spacing mealy bug population showed increasing trend up to 44th meteorological week.

The present finding are in agreement with the results reported by Muhammad Sarwar (2006), he revealed that the principal and key insect pests identified on guava including fruit fly, mealy bug, mites, guava moth and thrips. The average population of mealy bug 8.33 per tree was observed throughout the year on guava.

4.2 The correlation of major pests with abiotic factors in high density guava plantation

The weekly observation of maximum temperature ($T_{max.}$), minimum temperature ($T_{min.}$), relative humidity during morning (RH-I) and evening (RH-II) hours, rainfall (mm), rainy days and bright sun shine (B.S.S.) hours were recorded for the entire experimental period, from 1st June to 31st October 2014. The correlation coefficient of meteorological parameters with fruit infestation by guava fruit flies, anar caterpillar and castor capsule borer and number of mealy bugs, spiraling whiteflies and thrips were calculated to work out the effect of abiotic factors with pest population.

4.2.1 Fruit fly, *Bactrocera dorsalis*

The result of studies indicated that, the incidence of fruit flies (*Bactrocera dorsalis*) was noticed in 1st week of July (27th M.W.). It could be seen from Table 19 and Fig. 7 that the peak infestation of fruit fly (7.65%) was recorded in 2nd week of August (33 M.W.), during this period T_{max}, T_{min}, RH-I, RH-I, rainfall and B.S.S. were 31.7°C, 21.9°C, 70%, 50%, 34.0 mm and 4.8 hr, respectively. Thereafter, pest activity was slowly decreased and afterwards, reached at lowest level (2.99%) on 44th meteorological week during this period $T_{max.}$, $T_{min.}$, RH-I and B.S.S. were 32.0°C, 14.0°C, 56%, 36%, and 9.8 hr, respectively. Thus, it could be concluded that the hot and dry climate is detrimental and humid climate is more favorable for the build up fruit fly infestation.

The data on correlation between infestation of guava fruit flies under field conditions with abiotic factor indicated that there was significant positive correlation between population of fruit flies with minimum temperature, morning and evening humidity. The B.S.S. were found to be negative and highly significantly correlated with the fruit fly infestation.

The correlation between populations of guava fruit flies with meteorological parameters indicated that there was highly significant positive correlation with minimum temperature (r =0.707**), morning relative humidity(r =0.595**), evening relative humidity (r =0.614**) and non significant positive correlation with rainfall (r =0.283) and rainy days (r =0.376). There was highly significant negative correlation with B.S.S. hours (r=-0.647**) and non significant negative correlation with maximum temperature (r= -0.408) (Table 21).

Ranjitha and Shashidhar (2005), studied that *B.dorsalis* was observed significant negative correlated with maximum temperature and significantly positive correlation with minimum temperature and relative humidity (morning and evening). Sarada *et al.* (2001), revealed that fruit fly population had positive correlated with minimum temperature and rainfall and a positive non significant correlation with maximum temperature. Thus, these results reported during present study are in conformity with that of Sarada *et al.* (2001).

Ranjitha and Shashidhar (2006), studied on investigations of the population dynamics of fruit flies in mango orchard. The results revealed that population of *B. correcta* which was 9.94 fruit flies per trap per week during 27th standard meteorological week, first reached a small peak of 92.82 fruit flies during 29th week. The population was declined and remained at low level till 38th week.

4.2.2 Castor capsule borer, *Dichocrosis punctiferalis*

It could be seen from Table 19 that the incidence of *D. punctiferalis* was noticed in 1st week of July (27th M.W.). Maximum infestation (6.39%) was recorded in the 27th meteorological week, during this period $T_{max.}$, $T_{min.}$, RH-I, RH-I, rainfall and B.S.S. were 34.4^{o}C, 23.3^{o}C, 72%, 52%, 11.8 mm and 5.2 hr, respectively. It was reported that suddenly declined in infestation during the 31th meteorological week (3.62%). Afterwards, the fruit borer infestation was slowly reduced and reached at lowest level (1.35%) in 44th meteorological week, during this period T_{max}, T_{min}, RH-I, RH-I, rainfall and B.S.S. were 32.0^{o}C, 14.0^{o}C, 56%, 36%, 0.0 mm and 9.8 hr, respectively.

Thus it could be concluded that the reduce in temperature and BSS is favorable for the increase in the fruit borer infestation.

The castor capsule borer was observed to be highly significant and positive correlated with minimum temperature (r =0.725**), and non significant positive correlation with morning (r =0.400) and evening humidity (r =0.416) and highly significant negative correlation with BSS (r =-0.594**) were found to be negative non significantly correlated with T_{max} (-0.009).

Basavaraj *et al.* (2013), evaluated the population dynamics of castor capsule borer and they reported that the adults has significant negative correlation with maximum temperature (r =-0.80*) and BSS. Whereas, the larval population has significant positive correlation with relative humidity. Thus, the results reported during present study are in conformity with the result of Basavaraj *et al.*, 2013.

4.2.3 Anar caterpillar, *Deudorix isocrates*

It could be seen from Table 19 that the maximum infestation (5.54%) was recorded in the 34^{th} meteorological week, during this period $T._{max.}$, $T._{min.}$, RH-I, RH-I, rainfall and B.S.S. were 31.7^{o}C, 22.6^{o}C, 79%, 51%, 44.4 mm and 5.3 hr. respectively. Afterwards, these fruit borer infestation was slowly reduced and reached at lowest level (2.67%) in 44^{th} M.W. Thus, it could conclude that the humid climate with minimum temperature is more favorable for anar caterpillar infestation on guava.

Table 19. Infestation of fruit fly, anar caterpillar and castor capsule borer in guava *mrig bahar*, 2014

Met. week	Infested fruit per plant			Temperature ^0c		Relative Humidity		Rainfall (mm)	Rainy day	BSS hr.
	B. dorsalis	*D. punctiferalis*	*D.isocrates*	**Max.**	**Min.**	**I**	**II**			
27	5.93	6.39	3.93	34.4	23.3	72	52	11.8	1	5.2
28	6.19	6.00	4.00	32.7	23.4	73	52	16.8	2	3.8
29	6.15	5.02	4.70	30.8	24.0	72	63	0.0	0	1.1
30	6.75	3.92	4.18	29.1	22.3	76	63	23.4	3	4.1
31	7.41	3.62	4.16	29.0	22.6	75	68	13.2	3	2.2
32	7.10	4.14	4.93	30.5	21.9	72	57	1.6	0	5.1
33	7.65	3.52	5.51	31.7	21.9	70	50	34	1	4.8
34	7.47	3.72	5.58	31.7	22.6	79	51	44.4	3	5.3
35	5.81	3.50	5.30	28.6	21.8	81	72	130	5	1.4
36	6.52	2.74	5.06	29.5	22.2	75	66	15.0	1	3.7
37	5.81	3.05	4.72	30.7	21.0	71	57	0.0	0	5.2
38	4.68	2.70	4.60	31.9	21.0	71	51	4.0	1	8.0
39	5.24	2.41	4.41	33.6	20.0	70	41	0.0	0	8.7
40	3.71	2.09	4.10	34.1	22.2	70	40	0.0	0	7.5
41	3.49	2.09	3.83	34.0	19.6	64	33	7.4	1	8.0
42	3.67	1.67	3.56	33.7	20.9	73	43	13.4	2	8.1
43	3.15	1.55	3.13	29.4	16.1	72	57	1.0	0	4.9
44	2.99	1.35	2.67	32.0	14.0	56	36	0	0	9.8
Correlation coefficient	***B. dorsalis***			**-0.408**	**0.707****	**0.595****	**0.614****	**0.283**	**0.376**	**-0.647****
	D. punctiferalis			**-0.009**	**0.725****	**0.400**	**0.416**	**0.145**	**0.227**	**-0.594****
	D. isocrates			**-0.282**	**0.654****	**0.625****	**0.459**	**0.475**	**0.318**	**-0.474**

****significant at 1% level (0.5897)** ***significant at 5% level (0.4683)**

The *D. isocrates* infestation was observed to be highly significant and positive correlation with $T._{min}$ (r =0.654**) and RH-I (r =0.625**). The results indicates increase in minimum temperature ($T._{min}$) enhances the fruit borer infestation. However, BSS (r =-0.474) and $T._{max.}$ (r =- 0.282) were found to be non significant negative correlation with anar caterpillar infestation.

4.2.4 Guava thrips, *S. rubrocinctus*

The peak population of thrips (1.5 thrips/leaf) was recorded in the 28th meteorological week, then start to increase up to 38th meteorological week to attain maximum population (1.7thrips/leaf) during this period $T._{max.}$, $T._{min.}$, RH-I, RH-I, rainfall rainy days and B.S.S. were 31.9°C, 21.0°C, 71%, 51%, 4.0 mm, 4 day and 8.0 hr, respectively.

The data recorded from 27th to 44th meteorological week, 2014 revealed from Table 20 that increase in thrip population was highly significant positive correlation with minimum temperature (r=0.628**) and non significant positive correlation with RH-I (r= 0.352) and RH-II (r= 0.436). The thrip population was non significant negative correlation with BSS hours (r= -389), maximum temperature (r= -0.156) and rainfall (r = -0.07).

Demissie and Dahiya (2000) revealed that the mean temperature affect thrips population up to 52.35 %. Among the three abiotic factors, only the mean temperature affected the thrips population significantly. Thus, for the preliminary prediction model for thrips population, only the mean temperature was used while working on simple regression coefficient on different varieties and hybrids.

Muhammad *et al.* (2008) evaluated the incidence and development of *Thrips tabaci* and *Tetranychus urticae* was highly

Table 20. Incidence of sucking pests in guava mrig bahar, 2014

Met. week	Thrips	Spiraling whitefly	Mealy bug	Temperature⁰c		Humidity		Rainfall (mm)	Rainy day	BSS hr.
				Max.	Min.	I	II			
27	0.9	0.0	0.0	34.4	23.3	72	52	11.8	1	5.2
28	1.14	0.0	0.0	32.7	23.4	73	52	16.8	2	3.8
29	1.13	0.0	0.0	30.8	24.0	72	63	0.0	0	1.1
30	0.96	0.2	0.16	29.1	22.3	76	63	23.4	3	4.1
31	0.56	0.19	0.08	29.0	22.6	75	68	13.2	3	2.2
32	1.02	0.2	0.16	30.5	21.9	72	57	1.6	0	5.1
33	0.41	0.28	0.17	31.7	21.9	70	50	34.0	1	4.8
34	0.46	0.35	0.23	31.7	22.6	79	51	44.4	3	5.3
35	0.64	0.36	0.38	28.6	21.8	81	72	130	5	1.4
36	0.75	0.52	0.34	29.5	22.2	75	66	15.0	1	3.7
37	0.94	0.52	0.37	30.7	21.0	71	57	0.0	0	5.2
38	1.22	0.63	0.51	31.9	21.0	71	51	4.0	1	8
39	0.71	0.6	0.6	33.6	20.0	70	41	0.0	0	8.7
40	0.52	0.95	0.6	34.1	22.2	70	40	0.0	0	7.5
41	0.26	1.12	0.87	34.0	19.6	64	33	7.4	1	8
42	0.26	1.54	1.12	33.7	20.9	73	43	13.4	2	8.1
43	0.21	1.83	1.43	29.4	16.1	72	57	1.0	0	4.9
44	0.15	2.14	1.92	32.0	14.0	56	36	0.0	0	9.8
Correlation coefficient		**Thrips**		**-0.156**	**0.628****	**0.352**	**0.436**	**-0.070**	**-0.018**	**-0.389**
		Spiraling whitefly		**0.170**	**-0.89****	**-0.61****	**-0.551***	**-0.240**	**-0.330**	**0.648****
		Mealy bug		**0.149**	**-0.932****	**-0.645****	**-0.546***	**-0.207**	**-0.318**	**0.651****

****significant at 1% level (0.5897)** ***significant at 5% level (0.4683)**

affected by weather factors like mean air temperature, relative humidity and rainfall. Correlations between average population counts of cotton thrips and weather factor, the results shows that temperature played a significant and positive role for thrips (r = 0.645). Thus, the results reported during present study on the correlation of thrips with abiotic factors are in conformity with that of the Demissie and Dahiya, (2000) and Muhammad *et al.,* 2008.

Table 21: Correlation co-coefficient (r) of guava insect pests with meteorological parameters during 2014 (*Mrig bahar*)

Pest of guava	'r' values						
	$T._{max.}$ (°c)	$T._{min.}$ (°c)	RH-I (%)	RH-II (%)	Rainfall (mm)	Rainy days	BSS
Fruit fly	-0.408	0.707**	0.595**	0.614**	0.283	0.376	-0.647**
Fruit borer	-0.009	0.725**	0.400	0.416	0.145	0.227	-0.594**
Anar caterpillar	-0.282	0.654**	0.625**	0.459	0.475	0.318	-0.474
Thrips	-0.156	0.628**	0.352	0.436	-0.07	-0.018	-0.389
Spiraling whitefly	0.170	-0.890**	-0.61**	-0.551*	-0.24	-0.330	0.648**
Mealy bugs	0.149	-0.932**	-0.645**	-0.546*	-0.207	-0.318	0.651**

**significant at 1% level (0.5897) *significant at 5% level (0.4683)

4.2.5 Spiraling whitefly, *A. dispersus*

The peak population of spiraling whitefly was recorded in the 44th meteorological week, during this period maximum temperature, minimum temperature, RH-I, RH-I, rainfall and B.S.S. were 32°C, 14.°C, 56%, 36%, 0.0 mm and 9.8 hours, respectively (Table 20).

The spiraling whitefly population was found to be significant positive correlation with sunshine hr (0.648**) and non significant positive correlation with maximum temperature (Table 21). However, whitefly population showed significant negative correlation with RH-I (r=-0.61**), RH-II (r=-0.551*) and minimum temperature (r =-0.89**).

Aishwariyam *et al.* (2007) revealed that the incidence of all three stages of spiraling whitefly had significant positive correlation with maximum temperature and non significant negative correlation with (morning and afternoon) relative humidity, rainfall and minimum temperature.

Banjo (2010) reported that rainfall and temperature play a prominent role on the abundance and seasonal fluctuation of the spiraling whitefly and incidence, regulating their population. Moderate rainfall combined with high day temperature which usually occur between April and May, following the onset of rain after the very dry months (December and January) in Nigeria and other tropical regions favours high population of the spiraling whiteflies.

Thus results, reported during present study are in agreement with the Aishwariyam *et al.*, 2007 and Banjo, 2010.

4.2.6 Correlation of guava mealy bug

The mealy bug population was reached at peak in 44^{th} meteorological week. When max. temperature and Min. temperature were 32 and 14^{0}C, respectively. The relative humidity at morning and evening were 56 and 36%, respectively and bright sunshine hours was 9.8 hr (Table 20).

Mealy bug population was highly significantly positively correlated with BSS (r=0.651**) and non significantly positively correlated with maximum temperature (r=0.149) and significantly negatively correlated with RH-I (r=-0.645**), RH-II (r= -0.546*) and minimum temperature (r =-0.932**), and non significantly negative correlated with rainfall (Table 21).

The perusal of literature on the Correlation of guava mealy bug with abiotic factors revealed that there is no evidence of published literature on the guava mealy bug in relation with weather parameters which were used in present study.

Thus, it could be concluded that the increase in minimum temperature and relative humidity, there is drastic reduction in mealy bug population. The dry condition with low minimum temperature is favourable for the increase in the mealy bug population.

Table 22. Effect of different plant spacings on yield and yield contributing characters of guava cv. Sardar (L-49).

Sr. no.	Treatments (Spacing), m	No. of fruit per plant	weight of fruit (g)	Yield (Kg/plant)	Yield (tonnes/ha.)
T_1	1.0 x 1.0	11.80	102.50	1.20	12.00
T_2	1.5 x 1.5	15.60	132.50	2.34	11.38
T_3	2.0 x 1.5	22.41	152.50	3.42	11.35
T_4	2.0 x 2.0	27.38	169.25	4.62	11.55
T_5	6.0 x 6.0	45.26	225.08	10.18	2.80
	SEm ±	0.13	0.72	0.01	0.33
	C.D. 5%	0.46	2.24	0.02	1.04

4.3 Effect of plant spacing on yield

The yield of marketable guava fruits in kg from each treatment were recorded at each picking in kg. per plant and converted into tonnes per hectare. It could be seen from Table 22 and depicted in Fig. 13 that the maximum yield per ha was reported from 1.0 x 1.0 m (12 tonnes/ha) plant spacing. However, it was at par with 2.0 x 2.0 m (11.55 t/ha), 2.0 x 1.5 m (11.35 t/ha) and 1.5 x 1.5 m (11.35 t/ha) plant spacing except 6.0 x 6.0 m (2.80 t/ha) plant spacing.

The yield data recorded in Table 22 showed that the maximum (10.18 kg/plant) fruit yield per plant was recorded from 6.0 x 6.0 m plant spacing which was significantly superior over other four plant spacing, but the per ha. yield was low (2.80 t/ha) as compared to closer ultra high density plant spacing.

Kundu (2007), studied the effect of different plant densities, *viz*., 278 (6 x 6 m), 625 (4 x 4 m), 1111 (3 x 3m) and 1600 (2.5 x 2.5 m) plants per hectare in guava "L-49" studied in West Bengal. It is revealed that the increase in plant density markedly increased the plant height while decreasing the basal girth of the plant and spread of the crown. An increase in plant density from 278 to 1600/ha was decreased the yield from 36.8 to 27.9 kg/plant, reduced the fruit weight from 135.4 g to 125.7 g, but increased the yield per hectare area from 102.4 to 446.5 q/ha. Thus results, reported during present study are in agreement with the Kundu (2007).

5. SUMMARY AND CONCLUSIONS

5.1 SUMMARY

Guava *(Psidium guajava)* is an important fruit crops in tropical and subtropical regions of the countries due to the hardy nature of tree and prolific bearing even in marginal land. The traditional system of cultivation has often posed problem in attaining desired levels of productivity due to large tree canopy hence a need across to improve the existing production system, besides improve productivity. The high density meadow orcharding facilitated to enhance production and quality of fruits.

The present investigation was undertaken to study pests status in high density guava plantation and the correlation of these pests of guava with abiotc factors. The experiment was conducted at the Instructional cum Research orchard of guava, Department of Horticulture, MPKV, Rahuri from July to October, 2014. Summary of the work based on the result and conclusions are presented in this chapter.

5.1 The status of different pests in high density guava plantation

The present investigations were carried out to study the infestation of different pests of guava viz. fruit fly (*Bactrocera dorsalis),* anar caterpillar *(Deudorix isocrates)* and fruit borer *(Dichocrosis punctiferalis)*, and the population of thrips *(Selenothrips rubrocinctus)*, spiraling whitefly *(Aleurodicus disperses)*, and mealy bugs. The Correlation of abiotic factors *viz.,* maximum and minimum temperature, morning and evening relative humidity, rainfall, rainy days and bright sunshine hours, were worked out with major pests of guava. The observations on per cent infestation of fruit fly, anar caterpillar and fruit borer was taken separately at weekly interval by recording total and number of infested fruits from each spacing of guava meadow orchard plantation.

5.1.1 Effect of plant spacing on fruit fly, *B. dorsalis* infestation

The observations indicated that the first appearance of fruit fly *(Bactrocera* spp) infestation was noticed from 1st week of July i.e. 27th meteorological week under field condition. The data recorded in different experiments were statistically analyzed under Randomized Block Design. The data on the infestation of fruit fly revealed that less infestation of 2.95% was recorded in 6.0 x 6.0 m and it was at par with 2.0 x 2.0 m plant spacing. While, in 1.0 x 1.0 m (10.25%) registered higher infestation of fruit fly and it was at par with 1.5 x 1.5 m plant spacing during 2nd week of July. The fruit flies infestation was found maximum 11.00 % in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m (9.70%) plant spacing. While, minimum infestation of 4.75 % recorded in 6.0 x 6.0 m plant spacing during 2nd week of August (33rd M. W.). The fruit flies infestation increased every week and reached at peak level on 33rd M.W. then started to declined from the 37th M.W..

5.1.2 Effect of plant spacing on *D. punctiferalis* infesation

The result revealed that the infestation of castor capsule borer recorded highest (9.05%) in 1.0 x 1.0 m plant spacing in 1st week of July and it was at par with 1.5 x 1.5 m and 2.0 x 1.5 m plant spacing and recorded 7.65% and 6.80% infestation, respectively. Whereas, the 2.0 x 2.0 m plant spacing were recorded significantly lowest 4.13% infestation. It was however, at par with 6.0 x 6.0 m (4.33%) plant spacing.

The castor capsule borer infestation was maximum in ultra high density as compared to 6 x 6 m standard plant spacing. The incidence of *D. punctiferalis* was maximum during early fruiting period of crop from June to July and it was decline as season progresses.

5.1.3 Effect of plant spacing on *D. isocrates* infesation

The results revealed that anar caterpillar infestation was seen throughout the fruiting season of *mrig bahar*. The infestation was maximum (7.79%) in 33th meteorological week (3rd week of August) were recorded in 1.0 x 1.0 m plant spacing. However, it was at par with 1.5 x 1.5 m (6.30%) plant spacing. Whereas, 6.0 x 6.0 m standard plant spacing recorded least (3.60%) infestation and it was at par with 2.0 x 2.0 m (4.50%) plant spacing.

5.1.4 Effect of plant spacing on incidence of guava thrips, *S. rubrocinctus*

The significantly maximum population of thrips (1.73 thrips/leaf) was observed in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m plant spacing (1.45 thrips/leaf) in the 38th meteorological week. Whereas, 6.0 x 6.0 m plant spacing recorded significantly the lowest count (0.83 thrips/leaf) than other plant spacing except 2.0 x 2.0 m (0.90 thrips/leaf) which were statistically at par with each other. The population density of thrips was maximum found in closer spacing as compared to wider spacing.

5.1.5 Effect of plant spacing on incidence of Spiraling whitefly, *A. dispersus*

The results revealed that the incidence of whitefly was recorded significantly maximum i.e. 2.53 whiteflies/leaf in 1.0 x 1.0 m plant spacing in 44^{th} meteorological week and it was at par with 1.5 x 1.5 m and 2.0 x 1.5 m Plant spacing and recorded, 2.23 and 2.15 whiteflies/leaf, respectively. However, least incidence (1.73 whiteflies/leaf) was recorded in 6.0 x 6.0 m plant spacing and it was at par with 2.0 x 2.0 m (2.00 whiteflies/leaf) plant spacing.

5.1.6 Effect of plant spacing on incidence of guava mealy bugs

The maximum number of 2.38 mealy bugs per leaf were recorded in the 44^{th} meteorological week in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m (2.15 mealy bugs/leaves) plant spacing. The least population was reported in 6.0 x 6.0 m (1.48 mealy bug/leaf) and it was at par with 2.0 x 2.0 m and 2.0 x 1.5 m plant spacing when, the max. and min. temperature were 32 and 14^{0}C respectively and humidity at morning and evening were 56 and 36%, respectively.

5.2 The correlation of major pests with abiotic factors in high density guava plantation

The weekly observation on number of thrips, whiteflies, mealy bugs and per cent infested fruits due to fruit flies, anar caterpillar and castor capsule borer were correlated with abiotic parameters *viz.*, maximum temperature (T_{max}.), minimum temperature (T_{min}.), relative humidity during morning (RH-I) and evening (RH-II), rainfall (mm), rainy days and bright sun shine (B.S.S.) hours for the period, from 1 June to 31 October 2014.

5.2.1 Fruit fly, *Bactrocera dorsalis*

The result of studies indicated that, the incidence of fruit flies *(Bactrocera dorsalis*) was noticed in 1^{st} week of July (27^{th} M.W.). The infestation was maximum (11.0%) in 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m plant spacing. Whereas, standard recommended plant spacing 6.0 x 6.0 m recorded least (2.95%) fruit infestation in 2^{nd} week of August (33^{rd} M.W.) when the max. and min. temperature were 31.3 and 21.9^{0}C, respectively and humidity at morning and evening were 70 and 50%, respectively.

The guava fruit fly infestation was highly significant positive correlation with minimum temperature, relative humidity (RH-I and RH-II) and non significant positive correlation with rainfall and rainy day. The fruit fly infestation was highly significant negative correlation with BSS hrs. and non significant negative correlation with maximum temperature.

5.2.2 Castor capsule borer, *Dichocrosis punctiferalis*

The maximum (6.39%) infestation of *D. punctiferalis* was noticed in 1^{st} week of July (27^{th} M.W.). when the max. and min. temperature were 34.4 and 23.3^{0}C, respectively and humidity at morning and evening were 72 and 52%, respectively.

The castor capsule borer, *D. punctiferalis* infestation was highly significant positive correlation with minimum temperature and non significant positive correlation with humidity (evening and morning), rainy days and rainfall. The castor capsule borer infestation was highly significant negative correlation with BSS.

5.2.3 Anar caterpillar, *Deudorix isocrates*

The result of studies indicated that, the infestation of anar caterpillar was noticed in 1^{st} week of July (27^{th} M.W.).

The result of studies indicates that, the maximum (5.58%) infestation of anar caterpillar was noticed in 3rd week of August (34th M.W.). When, the max. and min. temperature were 31.7 and 22.6^{0}C, respectively and humidity at morning and evening were 79 and 51%, respectively.

The results revealed that *V. isocrates* infestation was observed to be highly significant positive correlation with minimum temperature and morning humidity and non significant negative correlated with maximum temperature, BSS hours. The results indicating that increase in temperature ($T._{min}$) enhances the anar caterpillar infestation.

5.2.4 Guava thrips, *S. rubrocinctus*

The maximum number of thrips (1.22/leaf) were recorded in 38th M.W. when, the max. and min. temperature were 31.9 and 20^{0}C, respectively and humidity at morning and evening were 70 and 40%, respectively.

The results revealed that thrips incidence was significant positive correlation with minimum temperature and non significant positive correlation with morning and evening humidity. The thrips population was non significant negative correlation with BSS, maximum temperature and rainfall.

5.2.5 Spiraling whitefly, *A. dispersus*

The result of studies indicated that, the incidence of Spiraling whitefly was noticed in 1st week of July (30th M.W.). Spiraling whitefly population was found to be significant positive correlation with BSS and non significant positive correlation with maximum temperature and significant negative correlation with relative humidity (RH-I and RH-II) and minimum temperature.

5.2.6 Guava mealy bugs

The maximum number of mealy bug (1.92/leaf) were recorded in 44th M.W. when, the max. and min. temperature were 32 and 14^{0}C, respectively and humidity at morning and evening were 56 and 36%, respectively.

Mealy bug population has significantly positive correlation with BSS and highly significant negative correlation with morning and evening relative humidity and minimum temperature.

5.2 CONCLUSIONS

Following conclusions were drawn from the present investigation

1. The per cent infestation of guava fruit flies, *Bactrocera* spp. was maximum in 1.0 x 1.0 m plant spacing and it, was at par with 1.5 x 1.5 m plant spacing and except 6.0 x 6.0 m and 2.0 x 2.0 plant spacing.
2. Among different plant spacing treatments, the treatment with 6.0 x 6.0 m plant spacing recorded less fruit fly and fruit borer infestation. While it, was at par with 2.0 x 2.0 m plant spacing and followed by 2.0 x 1.5 m plant spacing except, 1.0 x 1.0 m. and 1.5 x 1.5 m plant spacings.
3. The fruit fly infestation was highest (11.00%) in the 2nd week of August when, the max. temperature, min. temperature, relative humidity (RH-I and RH-II) and rainfall was, 31.7^{o}C, 21.9^{o}C, 70%, 50% and 34 mm, respectively. Whereas, lowest (4.15%) fruit fly infestation found in the 4th week of October.
4. The maximum infestation of castor capsule borer was reported in 1st week of July in 1.0 x 1.0 m plant spacing. While, it was found at par with 1.5 x 1.5 m plant spacing except, 2.0 x 2.0 m and 6.0 x 6.0 m plant spacing.

5. There was highly significant positive correlation of fruit flies infestation with minimum temperature, morning and evening humidity and significantly negative correlation with maximum temperature and BSS hours.
6. *D. punctiferalis* has highly significant positive correlation with minimum temperature and significant negative correlation with BSS hours and non significant positive correlation with humidity (morning and evening), rainfall and rainy days.
7. Among the treatments, 6.0 x 6.0 m and 2.0 x 2.0 m plant spacings recorded significantly less incidence of thrips, spiraling whiteflies and mealy bugs. The maximum pest population was registered in the 1.0 x 1.0 m plant spacing and it was at par with 1.5 x 1.5 m plant spacing.

The overall result clearly indicated that the fruit infestation due to fruit flies, castor capsule borer and anar caterpillar were maximum in ultra high density plantation as compared to standard recommended 6.0 x 6.0 m plant spacing.

The population density of thrips, spiraling whiteflies and mealy bugs were maximum in closer spacing as compared to wider spacing (6.0 x 6.0 m).

The present findings are based on only one bahar (*Mrig bahar*) data, further full season observations is essential to obtained conclusive results.

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<u>* Originals are not seen</u>

8. VITA

JADHAV SRIKANT UTTAMRAO

A candidate for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURE ENTOMOLOGY

Title of thesis	:	"Pests status in high density guava (*Psidium guajava*) plantation"
Major field	:	Agriculture Entomology

Biographical information

Personal	:	Born at Hunda Tanda, Tal. Umri Dist. Nanded (M.S.) on 7th July 1991 son of Shri. Uttamrao Somaji Jadhav and Smt. Parvati Jadhav.
Educational	:	Completed S.S.C. from Sharada Vidyalaya, Dhanora Tal. Umri Dist. Nanded in 2007 with 73.93% marks from Latur Board. Passed H.S.C. from Post Basic Junior College of Marwali Tanda,

in 2009 with 83.50% (1st class with distinction) from Latur Board. Completed B. Sc. (Agri.) degree from College of Agriculture, Parbhani, under V.N.M.K.V., Parbhani, (M.S.) in 2013 with 8.27 C.G.P.A. Rank 37th in All India M.Sc. (Agri.) JRF Entrance Examination, 2013 conducted by ICAR, New Delhi.

Address : At. Hunda Tanda, Tal. Umri Dist. Nanded (M.S.).

e-mail : jadhavskt0@gmail.com

Mob. no. : 9823225709

7. APPENDIX

Meteorological data

Met. weeks	Temperature (^0C)		Relative humidity (%)		Rainfall (mm)	No. of rainy days	BSS hr
	Maximum	Minimum	Morning	Evening			
July, 2014							
27	34.4	23.3	72	52	11.8	1	5.2
28	32.7	23.4	73	52	16.8	2	3.8
29	30.8	24.0	72	63	0.0	0	1.1
30	29.1	22.3	76	63	23.4	3	4.1
31	29.0	22.6	75	68	13.2	3	2.2
Aug., 2014							
32	30.5	21.9	72	57	1.6	0	5.1
33	31.7	21.9	70	50	34.0	1	4.8
34	31.7	22.6	79	51	44.4	3	5.3
35	28.6	21.8	81	72	130	5	1.4
Sept., 2014							
36	29.5	22.2	75	66	15.0	1	3.7
37	30.7	21.0	71	57	0.0	0	5.2
38	31.9	21.0	71	51	4.0	1	8.0
39	33.6	20.0	70	41	0.0	0	8.7
40	34.1	22.2	70	40	0.0	0	7.5
Oct., 2014							
41	34.0	19.6	64	33	7.4	1	8.0
42	33.7	20.9	73	43	13.4	2	8.1
43	29.4	16.1	72	57	1.0	0	4.9
44	32.0	14.0	56	36	0.0	0	9.8