

**SEASONAL INCIDENCE AND MANAGEMENT OF GUAVA
FRUIT FLY, *Bactrocera dorsalis* (Hendel)**

by

Miss. Khomane Kiran Balaso

(Reg. No. 2020/146)

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 ENTOMOLOGY
POST GRADUATE INSTITUTE
MAHATMA PHULE KRISHI VIDYAPEETH
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RAHURI - 413 722, DIST- AHMEDNAGAR
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2023**

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part
there of has not been submitted
by me or other person to any
other University or Institute
for a Degree or
Diploma

Place : M.P.K.V., Rahuri

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CERTIFICATE

This is to certify that the thesis entitled, “**SEASONAL INCIDENCE AND MANAGEMENT OF GUAVA FRUIT FLY, *Bactrocera dorsalis* (Hendel)**”, submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) in partial fulfilment of the requirement for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ENTOMOLOGY**, embodies the result of a piece of bonafide research work carried out by **Miss. KHOMANE KIRAN BALASO** 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 duly acknowledged.

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Place : M.P.K.V., Rahuri
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“Native ability without education is like a tree without fruit”

To reach a goal, you don't need to know all the answers in advance but you must have clear idea of the goal you want to reach. Success is possible only after involvement of many minds and hands to beautify it. Emotions can not be expressed in words because then emotions are transformed into mere formalities. Nevertheless, formalities have to be completed.

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Place : M.P.K.V., Rahuri

Date : / /2023

(Kiran B. Khomane)

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LIST OF ABBREVIATIONS

%	:	Per cent
/	:	Per
@	:	at the rate
>	:	greater than
CD	:	Critical Difference
CM	:	Centimeter
CV	:	Coefficient of Variance
Conc.	:	Concentration
EC	:	Emulsifiable Concentrates
<i>et al.</i>	:	et alia (And others)
<i>etc.</i>	:	Etcetera
Fig.	:	Figure
G	:	Gram
Ha	:	Hectare
<i>i.e.</i>	:	id est. (That is)
L	:	Litre
Ltd.	:	Limited
M	:	Meter
Mg	:	Milligram
ml	:	Milliliter
Mm	:	Milimeter
No.	:	Number
N.S.	:	Non Significant
Ppm	:	Parts per million
SD	:	Standard Deviation
SG	:	Soluble Granules
SL	:	Soluble Liquid
SMW	:	Standard Meteorological Week
Tr.	:	Treatment
WG	:	Wettable Granules

ABSTRACT**SEASONAL INCIDENCE AND MANAGEMENT OF GUAVA FRUIT
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by

Miss. KHOMANE KIRAN BALASO

A candidate for the degree

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MASTER OF SCIENCE (AGRICULTURE)

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AGRICULTURAL ENTOMOLOGY

2023

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

The present investigations were conducted during January to September 2022 at Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) Seasonal incidence was studied by installing methyl eugenol trap along with weather parameters like maximum and minimum temperature, morning and evening relative humidity and rainfall. The incidence of *Bactrocera dorsalis* was noticed from last week of January immediately after the installation of traps. From the data it was observed that fruit fly incidence started from 5th standard meteorological week and lasted upto harvesting of fruits *i.e.* 36th standard meteorological week. Fruit fly population ranged from 6.8 to 204 fruit flies/trap/week during the experimental period

The data indicated that there was significant positive correlation between population of fruit flies with minimum temperature ($r=0.372^*$) morning humidity ($r=0.363^{**}$) and evening humidity (0.844^{**}) rainy days ($r=0.489^{**}$) as well as wind velocity ($r=0.359^*$). However, fruit fly incidence showed significant negative correlation with maximum temperature ($r= -0.400^*$).

The field efficacy of 3 biopesticides and 4 chemical insecticides were tested against guava fruit fly, *Bactrocera dorsalis*. The different treatments *viz.* Wrapping of fruits, soil application of *M. anisopliae* 1.15 WP, azadirachtin 10000 ppm, karanj oil 1 %, spinosad 45 SC @ 150 g *a.i* /ha, acephate 75 SP @ 1 gm/L, flubendamide 8.83 % + deltamethrin 5.56 % SC @ 250 g *a.i* /ha, spinetoram 11.7 SC @ 56 g *a.i* /ha and untreated control were tested for their efficacy against guava fruit fly.

From the results of the pooled mean efficacy of treatments against guava fruit fly after spray revealed that treatment with wrapping of fruits was found to be most effective treatment with minimum mean per cent damage of fruit fly (2.99 %). However, it was followed by spinosad 45 SC @ 0.4 ml/L with minimum mean per cent damage (18.70 %), flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (24.17 %) followed by spinetoram 11.7 EC @ 0.5 ml/L (24.75 %), acephate 75 SP @ 1gm/L (24.80 %) were at

Abstract contd...**Miss. Kiran B. Khomane**

par with each other. Next promising treatment was azadirachtin 10000 ppm @ 3 ml/L (25.19 % fruit damage) followed by treatment with soil application of *M. anisopliae* @ 10 kg /ha (26.54 %) were found at par with each other. Moreover, karanj oil @ 3 ml/L (29.43 % fruit damage) and untreated control (42.27 %) were the least effective treatment. The above findings are based on the results of experimentation for only one season, which may be considered as mere indication and further investigation is necessary to arrive at definite conclusion.

Pages 1 to 47

1. INTRODUCTION

A sizeable portion of the world's agricultural output is made up of horticultural crops. The horticultural crops gives high export value, high yield and returns per unit area. Fruit and vegetable farming in India is a significant source of income. Fruits are significant because they are a good source of vitamins, minerals, sugar, protein and have a high nutritional value. For Indians, these crops are a significant component of their culinary tradition. Fruits and vegetables are in greater demand as a result of increased incomes, population growth and urbanisation (Diamantidis *et al.*, 2008).

India is one of the world's major fruit growing country in the world. In India wide range of fruit crops are grown including apple, pomegranate, banana, guava and sapota. Guava is one of the important fruit crop grown in India. Guava is native to Mexico, which is in tropical America and is a member of Myrtaceae family. Guava crop thrives in tropical and subtropical climates around the world (Sayed, 1970).

Guava growing regions within tropical and subtropical climates are rising as a result of increased demand for both fresh fruits and processed items in international trade. Guava (*Psidium guajava*) ranks as the fifth most significant commercial fruit. In India, guava ranks fourth in terms of commercial importance, after mango, banana and citrus. It is called the "poor man's apple" because it is a good source of calcium, phosphorus, and vitamin C. Guava fruit is an excellent bulk laxative since it contains a very high amount of dietary fibre (5.4 g per 100 g of fruit). It has a lot of vitamin C, with 100 g of fruit containing 228 mg of this vitamin more than thrice the daily recommended intake (Hinwar, 2013).

Since the early 17th century guava has been cultivated in India and has gradually evolved into a commercially important crop. Lucknow- 49 also known as 'Sardar guava' is a Poona selection developed by Dr. Cheema and Dr. Deshmukh. It is grown in various climatic circumstances, from sea level to 1515 metres in altitude (5000 ft). Guava can withstand dryness but not frost. Guava roots bark, and leaves have historically been used to treat gastrointestinal issues including gastroenteritis, diarrhoea, dysentery, ulcers, cough, chest problems like swollen gums, brain issues like nephritis, convulsions and cachexia (Naseer *et al.*, 2018).

In India total area under guava is 3.7 lakh ha with annual production of 45.16 lakh tonnes. In Maharashtra, it is grown on 1.21 lakh ha area with annual production of 12.97 lakh MT. The major guava producing states are Uttar Pradesh, Madhya Pradesh, Bihar,

Andhra Pradesh, Bihar, Haryana, Punjab, West Bengal, Gujarat and Karnataka. Maharashtra state ranks eleventh in area with annual of production 12.97 lakh MT. However, the share is very low *i.e.* 2.94 % and is mainly due to the insect pest problem (Anonymous, 2021).

Numerous factors that affect both quality and quantity of guava fruits responsible for low guava yield. Among the many problems that have been observed to affect guava at different stages, insects are a key one. Guava orchards worldwide are infested by almost 800 different types of insect pests, such as fruit flies, bark eating caterpillars and capsule moths. The infestation of fruit fly is a major limiting factor in the production of guava. Depending on the population, location, variety and season, the crop loss ranged from a few to 100 per cent (Kumar *et al.*, 2011 and Sharma *et al.*, 2015). It is in the range of 20-46 per cent with losses of 16-40 per cent (Haseeb, 2007), 13.40 to 46.60 per cent and 12.50 to 42.86 per cent, respectively on weight basis and number basis (Ukey *et al.*, 2012).

Fruit flies belong to family Tephritidae and order - Diptera. Tephritidae is the largest family, comprising more than 4000 species in 500 genera (White and Elson-Harris, 1992). This family is divided into 3 subfamilies *i.e.* Dacinae, Tephritidae and Trypetinae which are of economic importance. In oriental region almost 1000 species of fruit flies belong to family Tephritidae are recorded (Kapoor, 1993). There are about 325 species of fruit flies occurring in the Indian subcontinent, of which 205 are from India alone. The major pest species belong to the genus *Bactrocera*: *B. cucurbitae*, *B. dorsalis* and *B. zonata*, while other species, such as *B. correcta*, *B. diversa* and *B. latifrons* are still localized in their distribution (Kapoor, 2005). A total economic loss of 2,558 and 26,902 million rupees was estimated due to fruit flies in India with and without control measures, respectively. India has been included in the list of those countries from where import of fruits to developed countries is banned (Stonehouse, 2006).

B. correcta which was first identified in the Indian state of Bihar in 1916, is rapidly expanding throughout countries in South-East Asia, including Pakistan, Nepal, Burma, Thailand, Sri Lanka, Vietnam and China (Drew, 1994). A number of nations throughout the world have *B. correcta* listed as a pest that requires quarantine (White and Elson-Harris (2000).) Strong flyer, *Bactrocera zonata* can travel more than 24 kilometres in search of a host plant. It is active all year round when the temperature is above 10°C. Fruit fly complex is regarded as a significant quarantine pest around the world (Butani, 1979).

Fly adults are roughly the size of houseflies and range in colour from reddish brown to greyish black. The transparent wings have brown spots close to the tips. The

female, which has a pointed ovipositor, flies, settles on the fruit's soft part and punctures it with the ovipositor to lay her eggs beneath the fruit skin. Another female may use the same location for oviposition and egg laying. The fly spp. are widely distributed, multivoltine and have an explosive reproductive capacity (Drew and Hancock, 1994). Maximum activity of fruit flies, *Bactrocera* spp. in the month of September coinciding with fruiting season of guava whereas, lowest activity was reported in month of May (Dale, 2002).

Management of fruit flies is a difficult problem as maggots feed inside the fruits beyond the reach of insecticides. Moreover, due to good flying capacity, farm level efforts do not provide much control. Fruit flies pose a major threat to global trade therefore, preventing the entry of fruit fly by following strict quarantine measures is given emphasis rather than cure after entry or to prevent introduction of exotic species into previously uninfected areas. There are examples where losses have been up to 100 per cent in cucurbit species, caused by melon fly, *B. cucurbitae* (Dhillon *et al.*, 2005).

The occurrence of fruit fly in guava orchards is regular in Ahmednagar district of Maharashtra (India). With increase in the area under fruits like guava and cucurbitaceous vegetables, the intensity of this pest is increasing day-by-day. The seasonal incidence of any insect is very intimately associated with the weather parameters prevailing during preceding and corresponding period. The fruit flies activity was observed throughout the year in guava with peak periods in July–October (Batra, 1953 and Mann, 1996). Due to plenty of information available about fruit flies incidence, it becomes necessary to know the factors affecting the fruit fly population for effective management of pest. Each species of fruit fly reacts differently with environment (Sarada *et al.*, 2001).

Among the various alternate strategies available for the management of fruit flies, use of methyl eugenol trap stands as the most outstanding alternative. Methyl eugenol has olfactory action and is known to attract fruit flies from a distance of 800 m (Roomi *et al.*, 1993). Methyl eugenol when used together with an insecticide impregnated into suitable substrate, form the basis of male annihilation technique (MAT). This technique has been successfully used for the eradication and control of several *Bactrocera* species (Verghese *et al.*, 2006).

The area under guava cultivation is increasing in Ahmednagar district of Maharashtra state as cultivators are getting premium price throughout the year due to tourists visiting famous pilgrimage places as Shirdi and Shani Shinganapur. As the fruits are available almost a year round and with a view to increase the productivity, high density

planting technology is adopted in the area. It has resulted into higher infestation by fruit flies.

Considering all these things into account present study was planned to evaluate current status of guava fruit fly with the following objectives:

1. To study seasonal incidence of guava fruit fly.
2. To find out effective control measures for guava fruit fly.

2. REVIEW OF LITERATURE

Guava, *Psidium guajava* L., a popular fruit crop and one of the many tropical fruits, is valued for its flavour and nutritional benefits. It is extensively grown in the most of Indian states. There is a lot of potential to export these fruits to other nations because of the rising foreign demand for them. According to reports, fruit flies are infesting guava fruits, reducing fruit yield and damaging the fruits' capacity to be exported, which eventually disrupts the nation's economy.

The literature pertaining to the seasonal incidence of guava fruit fly and to find out different control measure for guava fruit fly is reviewed and presented in this chapter.

2.1 To Study Seasonal Incidence of Guava Fruit Fly

The attack by *D. dorsalis* was observed in the beginning of July and continued uninterruptedly throughout the season in Delhi and observed the peak incidence of fruit flies from July to September (Narayan and Batra, 1960).

Qureshi *et al.* (1974) revealed that *D. zonata* population was lowest in January-February and increased gradually to reach its peak in March-May in Pakistan. Further, the population declined in June-July and again increased in August reaching another peak in September. Moreover, they reported that, the micro environment appeared to play an important role in population fluctuation.

Belavadi (1979) observed two peaks of *B. dorsalis* during the months of March-May and September November under Dharwad conditions.

Liu *et al.* (1985) observed a decline in population of *B. dorsalis* from November to early May under Taiwan conditions. Adult population of *D. dorsalis* declined from November to early May, then increased exponentially to a peak in June and lasted until September in Taiwan, China.

Shukla and Prasad (1985) reported three distinct population peaks of *D. dorsalis* during March-April, May-June and September-October at Hessaraghatta, Bangalore and reported that, *B. dorsalis* had significant correlation with temperature and relative humidity. They noticed a negative correlation between weekly rainfall and *B. dorsalis* population and a negative correlation with average number of dry light hours.

Zhi Ying *et al.* (1995) reported that, second generation of *B. dorsalis* was most important feeding on mango, peach and guava fruits. They further reported that the peak period of adult catches was during June -July with exception of citrus and sweet orange

orchard (September - October and October -December, respectively). They also concluded that, the peak period and number of adult occurrence differed between year to year.

Hwang *et al.* (1997) observed the peak incidence of *Bactrocera* spp. from June to September. A decrease in the population was observed during winter.

Makhmoor and Singh (1998) reported highest trap catches of *D. dorsalis* during July in Jammu and Kashmir maximum and minimum temperature was 33.6°C and 22.5°C and relative humidity was 90.3 and 57 per cent, respectively. The further reported that, temperature had a negative correlation while relative humidity and rainfall had a positive correlation with the population of *B. dorsalis*.

Verghese *et al.* (1998) monitored *B. dorsalis*, a serious pest of mango and guava by 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 coefficient of determination equal to 36 per cent, based on a linear model.

Agarwal *et al.* (1999) studied the population dynamics of *B. zonata* (Saunders) during April-August, 1997 in North Bihar. Maximum fly population was recorded during third week of June (357.0 flies/trap) while minimum during last week of August (14.3 flies/trap).

Jalaluddin *et al.* (1999) recorded three peaks of *B. zonata*, *B. correcta* and *B. dorsalis* in Tamil Nadu. The first peak occurred during 2nd fortnight of June, 2nd peak during 2nd fortnight of July and 3rd peak during 2nd fortnight of August.

Gupta and Bhatia (2000) recorded the maximum of 427.2 and 517.0 males/trap of *B. dorsalis* and *B. zonata* respectively, in Haryana during September 2000. There was a significant positive correlation between trap catches and maximum and minimum temperature.

Clarke *et al.* (2001) reported that, *B. dorsalis* and *B. correcta* exhibited unimodal patterns of population abundance with peak incidence from June to September in guava.

According to Jalaluddin *et al.* (2001), peak activity of guava fruit fly (223.5 flies /traps) observed during 4th week of November and studied distinct population peak of *B. correcta* 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 highest population of *Bactrocera* spp. during November and lowest during March in guava orchard of Andhra Pradesh. In correlation study, positive correlation with relative humidity, rainfall and negative with maximum temperature was observed at Tirupati.

Chaudhary and Jamal (2002) observed peak activity of *B. zonata* and *B. dorsalis* from August to October which coincided with the maturity of guava under various environmental conditions of Rawalpindi, Pakistan.

Dale (2002) from North Gujarat, recorded 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 reported that the fruit fly population had significant positive correlation with minimum temperature, relative humidity (maximum, minimum and average) and rainy days whereas, negative correlation with maximum temperature, sunshine hours and rainfall. Peak population of *B. dorsalis* observed during July 2003 and January 2004. Whereas, *B. correcta* population reached to its peak during July to November, 2003 while no significant peak was recorded in the year 2004. Highest population of *B. zonata* reached during October, 2003 and March, 2004.

Gillani *et al.* (2002) had studied seasonal dynamics of fruit flies in guava orchard with the help of methyl eugenol and cue lure trap and found three species *i.e.* *D. dorsalis*, *D. zonata* and *D. cucurbitae*. These flies were caught in the traps in greater number from May to August and their population was at its peak in July in guava (80.66 males/trap/week). *D. cucurbitae* was present in the field for short period from August to November and in reasonable numbers only in October. Among these flies *D. zonata* was more dominant than other species in guava.

Iwaizumi (2004) studied the species diversity of melon fruit fly in Japan and reported seven species of *B. dorsalis* complex, *B. dorsalis*, *B. papayae*, *B. carambolae*, *B. philippinensis*, *B. occipitalis*, *B. caryae* and *B. kandiensis* were found in a total of 1,093 specimen collected from 136 fruit samples.

Laskar and Chatergee (2004) recorded studies that higher population density of melon fruit fly recorded during the hot months while, low or very low during cooler months. So, it is very clear that, crops should grown during cool months *i.e.* in 'rabi' season so as to avoid infestation of this dreaded pest.

Patel *et al.* (2005) conducted studies on attraction of fruit flies to methyl eugenol in soaked plywood blocks containing 5 ml methyl eugenol and as 100 g of crushed *Ocimum sanctum* in traps in the guava orchards near Gandevi (Gujarat). Trap baited with methyl eugenol showed, better results to attraction of fruit flies. Methyl eugenol trap attract *B. dorsalis*, *B. zonata* and *B. correcta* in guava orchard near Anand, Gujarat.

Thomas *et al.* (2005) conducted a field experiment in bitter melon near Thrissur (Kerala) using cue lure traps and found 151 catches of melon fruit fly (*B. cucurbitae*) in bitter melon fields over two weeks.

Ravikumar (2006) observed three peaks of *B. dorsalis* during 27th, 45th and 48th standard weeks while *B. correcta* had the major peak during 27th standard week in 2004. *B. zonata* had two peaks during 11th and 18th standard weeks of 2005.

Chen *et al.* (2006) had studied movement of *B. dorsalis* in guava orchard of Taiwan and showed the populations of *B. dorsalis* in guava orchard peaked in April through May and August to October which coincided with the main fruiting seasons of guava.

Ranjitha and Viraktamath (2006 a) studied occurrence of *B. dorsalis*, *B. correcta* and *B. zonata* throughout the year in guava at Dharwad. Peak catch of *B. dorsalis* 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. Two peaks of *B. correcta* were observed during 30th (123.69 fruit flies) and 45th standard weeks (362.67 fruit flies) in 2003. In 2004, no significant peak was observed. *B. zonata* had three major peaks during 42nd standard week (15.19 fruit flies) in 2003 and 11th and 12th standard meteorological weeks in 2004 with 17.71 fruit flies. When total number of fruit flies was considered, three peaks were observed during 30th (157.64 fruit flies), 43rd (218.75 fruit flies) and 45th (379.82 fruit flies) standard meteorological weeks in 2003. In 2004, major peak was during 3rd (107.10 fruit flies) standard meteorological week. All weather parameters together influenced trap catches of *B. dorsalis*, *B. correcta* and *B. zonata* to the extent of 56.70, 12.0 and 53.30 per cent.

Ranjitha and Viraktamath (2006 b) has investigated the population fluctuation of fruit flies in mango orchard at Dharwad and reported three species of fruit flies namely, *B. dorsalis*, *B. correcta* and *B. zonata* were recorded in methyl eugenol traps. Population of *B. dorsalis* which was 8.33 fruit flies /trap during 27th standard week in 2003 reached a major peak of 22.47 fruit flies during 30th standard week. Later the population declined and remained at a low level with slight fluctuations. Peak catches of *B. correcta* was

observed during 39th meteorological week to 45th standard meteorological week *i.e.* August to November.

Ravikumar and Viraktamath (2006) studied the influence of weather parameters in guava orchard in Dharwad and found that of *B. correcta* reached to its peak during first week of July in 2004 and fourth week of May in 2005. *B. dorsalis* had three peaks in 2004 *i.e.* First week of July, second and fourth week of November while in 2005, the population peaked during second week of March and May. Population of *B. zonata* showed one major peak in 2004 during second week of November and two peaks in 2005 during third week of April and May. In guava, *B. correcta* and *B. zonata* had significant positive correlation with temperature, while *B. dorsalis* had significant negative correlation with morning relative humidity and rainfall.

Mahmood and Mishkatullah (2009) studied the population dynamics of three pest species, peach fruit fly, *B. zonata*, melon fruit fly, *B. cucurbitae* and oriental fruit fly, *B. dorsalis* in Barani Agricultural Research Institute, Chakwal, Northern Punjab. The fruit flies showed a low population level from November to February and increased level from March to August. The population peak appeared in July and August and maximum declined was observed in October depending on the host fruit maturity, temperature and rainfall.

Deepa *et al.* (2009) studied relationship between trap catches of *Bactrocera* species revealed occurrence of *B. dorsalis*, *B. zonata* and *B. correcta* and weather parameters such as rainfall, temperature and average relative humidity. In horticulture orchard, peak catches of *B. zonata* was observed on second week of October 2006 and second week of March 2007 with the trap catch of 32.3 fruit flies/trap/week. *B. correcta* peak catch was observed during second week of December 2006 and second week of April 2007 with the trap catch of 30.0 and 47.6 fruit flies/trap /week. *B. dorsalis* peak catch of 2 fruit flies/trap/week observed during in 2006 peak catch of 46.6 fruit flies /trap/week observed during 2007 in April.

Kate *et al.* (2009) studied seasonal incidence of fruit fly, *B. cucurbitae* (Coquillett) on cucumber and revealed that, infestation of fruit fly commenced during 5th week after germination and increased during next four weeks (6th, 7th, 8th and 9th week after germination) and formed the peak with an infestation of 22.4 per cent. Then, the infestation declined gradually up to 12.00 per cent during last week of April *i.e.* 12th.

Abdel Galil *et al.* (2010) studied population fluctuations of the Mediterranean fruit fly *C. capitata* (Wiedemann) and the peach fly, *B. zonata* (Saunders) in three provinces in

the New Valley Oases, Western Desert and Egypt. The occurrence of *B. zonata* in high numbers was recorded over the study period as compared to *C. capitata*.

Vishla *et al.* (2010) studied population fluctuation of mango fruit flies at Saharanpur, Uttar Pradesh and revealed that population increased gradually from 5 flies in first week of February to 191 flies in the second week of September during year 2007. Thereafter, population declined with decreasing temperature from fourth week of September (100 flies) and reached to its lowest level in fourth week of December (1 flies) to first week of January (0.5 flies). The correlation of fruit flies population were positively significant with minimum temperature ($r=0.8108$) and maximum temperature ($r=0.6061$). However, non-significant positive correlation was found with relative humidity ($r=0.1118$).

Ghule *et al.* (2014) reported, incidence pattern of *B. cucurbitae* (Coq.), *Henosepilachna septima* (Dieke) and *Aulacophora foveicollis* (Lucas) on cucumber. Peak fruit fly larval incidence was recorded during third week of February, 2011 (20.57 maggots/fruit) and second week of February, 2012 (20.70 maggots/fruit). Highest per cent fruit damage observed during third week of February, 2011 (86 %) and last week of February, 2012 (44.17 %). Fruit fly incidence had positive significant association with maximum temperature ($r=+0.870$) and minimum temperature ($r=+0.730$) whereas, it had negatively significant correlation with minimum relative humidity ($r=-0.738$).

Khan and Naveed (2015) conducted field experiment and population of *B. zonata* was monitored using methyl eugenol traps during 2015. Occurrence and population dynamics of fruit fly were compared with meteorological factors such as temperature, relative humidity and sunshine. The highest mean population of fruit fly remained at 499 in the month of August. It had started to decline afterwards and remained at 348 in the month of September. The lowest population of 26, 3, 2 and 1 fruit flies /trap/week were recorded in the month of November, December, January and February, respectively. The optimum monthly average temperature and relative humidity ranged from 26 to 35 °C and 60 %, respectively. The population of fruit fly was positively correlated with temperature and negative correlation was seen for relative humidity.

According to Bhowmik (2017), among various management strategies of fruit flies, use of methyl eugenol traps stands as most outstanding alternative. To monitor incidence and management through mass trapping of fly, experiments were conducted at three locations of Nadia districts (Jaguli, Kalyani and Haringhata) of West Bengal with methyl eugenol (ME) during 2012 and 2013. Three types of traps (trap-1: Cotton impregnated

with ME, trap-2: ME added in water and trap-3: ME mixed with banana and sevin) were used in three orchards of each location. The maximum mean number of fly catch/trap/day was in mango and banana (14.42 and 16.39) in trap-1, mango (14.04 and 11.24) in trap-2 and guava, mango (11.06 and 10.77) in trap-3 during 2012 and 2013, respectively. Trap-1 (13.16 and 15.23 catch/day) was found most effective during 2012 and 2013, respectively.

Math and Kotikal (2017) conducted a study related to species diversity and seasonal incidence of fruit flies in guava ecosystem at University of Horticultural Sciences (UHS), Udyanagiri, Bagalkot, India during 2015-16 and 2016-17. The species diversity indices of fruit flies during 2015-16 showed that Shannon index of diversity of the fruit fly population was maximum during 48th standard meteorological week SMW of (November) 2015 (H=1.06), followed by 27th SMW of (July) 2015 (H=0.83). Maximum J' value was recorded (J'=0.98 and 0.96, respectively) during 40th and 51st SMW of 2015 and 1st, 3rd and 48th SMW of 2016.

Kumar *et al.* (2018) studied that throughout the year, four different species of fruit flies *B. dorsalis*, *B. zonata*, *B. correcta* and *B. diversa* were identified by using methyl eugenol trap on mango orchards. The incidence of fruit flies was correlated with weather data. The maximum and minimum population of *B. dorsalis* was recorded in the months of August and January on mango orchard both at Saharanpur and Meerut District. Where, the maximum and minimum population of *B. zonata* was recorded in the month of July and January on mango orchard. Population of *B. diversa* and *B. correcta* were very low on mango orchard throughout the year.

Saha *et al.* (2018) studied population dynamics of prevailing six insect-pests of cucumber and its natural enemies in relation to weather parameters. The correlation studies between insect pests and weather parameters revealed that the melon fruit fly (*Bactrocera cucurbitae* Coquillett), Epilachna beetle (*Epilachna vigintioctopunctata* Fabricius), red pumpkin beetle (*Aulacophora foveicollis* Lucas), whitefly (*Bemisia tabaci* Gennadius), pumpkin caterpillar (*Diaphania indica* Saunders) and leaf miner (*Liriomyza trifolii* Burgess) showed significant positive correlation with maximum and minimum temperature, whereas negative and non-significant correlation with relative humidity and rainfall.

Afroz *et al.* (2019) investigated the effect of weather parameters on abundance of the insects. Red pumpkin beetle, Epilachna beetle and fruit fly showed the highest level of infestation during 3rd week of December, 3rd week of January and 4th week of February 2019, respectively. All the insects revealed the lowest level of infestation on BD274 and

BD277 germplasm. Relative humidity had insignificant positive correlation with all the insects. Red pumpkin beetle showed significant positive correlation with temperature. Temperature, relative humidity and rainfall showed 43.2 per cent contribution on fruit fly abundance and the individual effect of relative humidity was the highest (27.0 %).

Vignesh *et al.* (2020) studied the incidence and spread of *Bactrocera* spp. in guava orchards throughout the experimental period. They found that identification of trapped fruit flies at species level by using taxonomic keys clearly indicated that the diversity and population of *B. dorsalis* and *B. correcta* were more prevalent in guava ecosystem.

Kumar *et al.* (2022) conducted experiment on population dynamics of fruit fly (*Bactrocera* spp.) in cucurbits at different locations at Department of Entomology, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, during 2020-21. Trapping of fruit fly was started from the 9th SMW and continued up to 25th SMW by using sex attractant, Cue lure and methyl eugenol traps. The incidence of *B. cucurbitae* and *B. tau* was observed high (33.41 fruit flies/trap/week) and (18.00 fruit flies/trap/week), respectively on 20th SMW caught through cue lure. Mean population of *B. cucurbitae*, *B. tau* showed non-significantly positive correlation with minimum temperature and significantly positive correlation with maximum temperature however, it was significantly negatively correlated with relative humidity and non-significantly negative correlated with rainfall, respectively.

2.2 To Find Out Effective Control Measures for Guava Fruit Fly

Singh and Srivastava (1983) found that alcohol extract of neem oil, *A. indica* (5 %) reduced oviposition of *B. cucurbitae* on bittergourd completely and its 20 % concentration was highly effective to inhibit oviposition of *B. zonata* on guava.

Akhtaruzzaman (1999) studied the efficacy of bagging to suppress cucurbit fruit fly infestation and revealed that the mean of all stages of fruit fly infestation was significantly lower (5.53%) in treatment (T2) where in bagging of fruits at 3 days after anthesis was made and retained for 5 days.

Kumar and Singh (2002) reported that, many biopesticides have been developed from trees including neem (*Azadirachta indica*), Karanj (*Pongamia pinnata* or *P. glabra*), mahua (*M. indica* or *M. longifera*) and chinaberry (*Melia azedarach*). Among these, oil, methanolic seed extract, aqueous seed extract and petroleum ether seed extract of karanj were evaluated and found to act as oviposition deterrents, antifeedants and larvicides against a wide range of insect pests.

Dhillon *et al.* (2005) reported that melon fruit fly could be successfully be managed over a local area by bagging fruits, field sanitation, protein baits, cue-lure traps, growing fruit fly-resistant genotypes, augmentation of biocontrol agents and soft insecticides. The wide area management program involved coordination of different characteristics of an insect eradication program (including local area options) over an entire area within a defensible perimeter and subsequently protected against reinvasion by quarantine controls. Although, the sterile insect technique has been successfully used in wide area approaches, this approach needs to use more sophisticated and powerful technologies in eradication programs such as insect transgenesis and geographical information systems, which could be deployed over a wide area.

Aemprapa (2007) evaluated several strains of *B. bassiana* and *M. anisopliae* against *B. dorsalis* adults and the results indicated that the most virulent strain produced 68 per cent with a mortality LC₅₀ of 7.36×10^7 conidia/ml.

Khan *et al.* (2007) tested neem leaf dust and commercial formulation of neem on adult *Bactrocera cucurbitae* and *Bactrocera dorsalis* to determine their effect on longevity, fecundity and ovarian development. They found that, mean longevity of adult of *Bactrocera dorsalis* feed on neem integrated diet significantly lower.

Nath *et al.* (2007) reported that, NSE 5 %, bait spray (Malathion 50 ml + molasses 500 g + water 50 L) and cypermethrin applied one after another as per schedule resulted in minimum fruit damage by fruit fly.

Amin *et al.* (2008) conducted experiment to know the economic effect of different management practices. Application of Nimbicidine @ 5 ml/L, Secufon 80 SP @ 1 ml/L, Decis 2.5 EC @ 1 ml/L and bagging of fruits at two days after anthesis on *B. cucurbitae* in sweet gourd (*Cucurbita moschata*). The evaluation of different management practices revealed that, bagging of fruits in scaffold showed lowest level of infestation and demanded the highest cost (356.45 US \$) per hectare. The highest yield (19.51 t/ha) was obtained in bagging treatment and resulted lowest benefit: cost ratio (06.89). It was concluded that bagging of fruits was found to be as a superior method in controlling damage by fruit fly in sweet gourd.

Kapoor (2005) found that, fruits is covered by a paper or cloth bag block the contact of flies with the fruit thereby protecting from oviposition by the fruit fly.

Khan *et al.* (2015) studies that hoeing under the tree canopy at 15 days interval along with collection of fallen fruits and burying deep in the soil and spray of spinosad

was found to be most effective in reducing average fruit fly infestation to 6 per cent and 6.3 per cent for the year 2013 and 2014 respectively.

Mondal *et al.* (2015) reported that fruit fly infestation varied between 1.32 to 17.31 per cent in all treatments using wrapping transparent polypropylene bags and 13.14 per cent in case of combined use of pheromone trap (Bacu-lure).

According to Sharma *et al.* (2013) pre-harvest fruit bagging is a good technique to maintain a physical separation between the environment and the produce. One of the most significant effects of fruit bagging has been protection from the damage caused by insect pests. Several studies have indicated that bagging reduced the incidence of fruit fly in guava.

Sarkar *et al.* (2017) carried out field and laboratory studies to find out the extent of fruit fly infestation at different fruiting stages of bitter gourd as well as to determine the efficacy of some pesticidal and other control approaches applied either separately or in combination. The pesticidal efficacy of three commonly used insecticides such as secufon, malathion, karate and karanja oil as botanicals with the concentrations of 0.25, 0.50, 0.75 and 1.00 per cent, respectively was determined against the larvae of cucurbit fruit fly, *B. cucurbitae* in the laboratory based on mortality at different time intervals. All the pesticides caused maximum mortality at 72 hr with 1.00 per cent concentration. The level of fruit fly infestation at different fruiting stages of bitter gourd ranged from 8.91 to 88.19 per cent, 9.24 to 94.89 per cent and 5.01 to 89.27 per cent at early, mid and late fruiting stage, respectively. The other control approaches viz., sex pheromone, bait trap with secufon + cucurbit chop, bait trap consisted of secufon + banana chop reduced fruit fly infestation to a significant level. The highest number (83.67) of flies trapped at mid fruiting stage of bitter gourd was recorded in sex pheromone trap while the ratio of male and female flies ranged from 1.13 to 1.24 in the trapped individuals.

Shivangi *et al.* (2017) investigated the bio-efficacy of different bio-intensive treatment modules against cucurbit fruit fly, *B. cucurbitae* in cucumber during *kharif*, 2016. The results revealed that, among eight spray combinations of biopesticides viz. Spinosad (200 ml/ha), Azadirachtin (0.03 %) and NSE (5 %), three sprays of spinosad (200 ml/ha), first spray applied as soon as the ovipositor marks were seen on the fruits and subsequent sprays at an interval of twelve days proved to be the most effective treatment module in controlling the fruit fly with least mean number of fruits with ovipositor marks (1.50), mean number of pupae of fruit fly formed from damaged fruits (5.92) and mean per cent fruit infestation (8.28 per cent). The treatment module comprising two spray

applications of spinosad (200 ml/ha) followed by a spray of azadirachtin (0.03 %) was the next effective treatment.

Hirekurubar *et al.* (2018) revealed that minimum per cent fruit damage of 14.27 was recorded in spinosad 45 SC @ 0.3 ml/L treated plot, making it most effective treatment followed by chlorantraniliprole 18.5 SC @ 0.2 ml/L (16.97 %) which was at par with deltamethrin 2.8 EC @ 0.5 ml/l (20.35 %). Spinosad 45 SC @ 0.3 ml/L treated plot registered highest fruit yield (22.08 t/ha) which was at par with chlorantraniliprole 18.5 SC @ 0.2 ml/L (20.16 t/ha) and significantly superior than deltamethrin 2.8 EC @ 0.5 ml/L (18.86 t/ha). The yield obtained from NSE 5 % (16.86 t/ha) and azadirachtin 1500 ppm @ 5 ml/l (16.95 t/ha) were also found at par with deltamethrin 2.8 EC @ 0.5 ml/L and significantly higher than untreated control (13.51 t/ha). The highest cost benefit ratio of 1: 2.64 was obtained in spinosad 45 SC treated plot.

Nehra *et al.* (2019) among the insecticides evaluated against fruit fly on round gourd, spinosad was found most effective. The next effective treatments were acephate + molasses followed by acephate and fipronil. The treatments of Neem Gold and NSKE were found least effective. The maximum marketable yield of round gourd fruits was obtained in spinosad (105.14 q ha⁻¹) followed by acephate + molasses (102.57 q ha⁻¹) whereas; minimum (50.12 q ha⁻¹) was in NSKE. The maximum net profit of Rs. 90956 ha⁻¹ was obtained in treatment of Acephate + molasses, whereas, minimum net profit of Rs. 13176 ha⁻¹ was in NSKE. The highest benefit cost ratio was computed in acephate (1:59.41), while the minimum was in Neem gold.

Shinde *et al.* (2021) reported that spinosad 45 SC was the most effective treatment which recorded minimum (19.38 %) mean fruit infestation and was at par with Deltamethrin 2.8 EC (20.34 %) continued its superiority over rest of the treatments under study. The next best treatments were azadirachtin 10000 ppm (25.21 %), emamectin benzoate 5 SG (27.48 %), dichlorvos 76 EC (26.14 %), dashparni ark (31.67 %) and lantana extract (34.03 %) were statistically at par with each other.

Meena *et al.* (2022) evaluated five insecticides and four botanicals for their bioefficacy against fruit fly, *B. cucurbitae* and revealed that spinosad 45 SC (0.013 %) was most effective followed by indoxacarb 14.5 SC (0.010 %) and acephate 75 SP (0.075 %). The next effective treatments were dimethoate 30 EC (0.030 %) and quinalphos 25 EC (0.025 %). The treatments khimp and tumba extract were found least effective against fruit fly infestation.

Yaligar *et al.* (2022) observed that amongst all tested chemicals flubendamide 90 SC + deltamethrin 60-150 SC @ 22.5+15 g *a.i*/ha was found to be significantly superior in reducing the per cent leaf damage caused by pumpkin beetle, fruit fly and cucumber moth by suppressing population of plot treated with flubendamide 90 SC+ deltamethrin 60 -150 SC@ 22.5 + 15g *a.i* /ha produced the maximum fruit yield than other treatments and had less impact on natural enemies.

3. MATERIAL AND METHODS

The present investigation entitled “Seasonal incidence and management of guava fruit fly” was carried out at All India coordinated Research Project on fruits, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri during January 2022 to September 2022. The material and methods adopted during the entire course of investigations are described under the following heads. Considering the persistent need for an effective management strategy for fruit fly as a major pest of guava it becomes imperative to undertake the present investigation on guava fruit fly, *Bactrocera dorsalis*.

3.1 To Study Seasonal Incidence of Guava Fruit Fly

The trapping of fruit flies in guava orchards planted with Lucknow 49 variety were made by keeping para-pheromone traps containing methyl eugenol as fruit fly attractant. Traps were obtained from the Department of Entomology, MPKV, Rahuri and installed in the experimental plot. The traps were made up of plastic with yellow bowl having entry hole of 6 cm in diameter and transparent dome contained lure holder. The white cylindrical jar type trap of about 15 cm height and 10 cm diameter with two holes of size about 5 cm diameter in the sidewall, which acted as entry point for fruit fly were taken for monitoring fruit fly activity in guava orchard. A wooden dispenser of size 4 x 2 x 1 cm³ charged with methyl eugenol was hanged at the top of the trap using an iron wire acted as an attractant for fruit fly. Top of the trap was entirely sealed and the perforated bottom was screw with the jar trap.

The perforations present in the bottom of the trap aided in drainage of rain water. The traps were placed in guava orchard randomly at a height of 1.5 m above ground level and at spacing of 40 meter distance between two traps to avoid trap interference effect. The fruit flies trapped were collected at weekly interval (Messing, 1999).

3.1.1 Method of Recording Observations

The observations on number of fruit flies trapped/week/trap were recorded at weekly interval started from 5th SMW to 36th SMW during 2022. The adult fruit flies were counted and explained in each of methyl eugenol trap. The correlation coefficient between various climatic factors and incidence of fruit flies was worked out by using standard statistical procedure given by Drew, 1989.

3.1.2 Recording of Meteorological Data

Data on different weather parameters *i.e.* Maximum temperature(°C), minimum temperature(°C), morning relative humidity (%), evening relative humidity (%), rainfall

(mm), rainy days and wind velocity (km/hr) were obtained from meteorological observatory located at central campus MPKV, Rahuri.

3.2 Material

3.2.1 Traps

The traps were made up of plastic and it had yellow bowl with entry hole of 5 cm diameter and transparent dome with lure holder.

3.2.2 Chemicals for Trapping

A wooden dispenser of size 4 x 2 x 1 cm³ charged with methyl eugenol was hanged at the top of the trap using an iron wire acted as an attractant for fruit fly.

3.2.3 Pesticide and Appliances

The insecticides used for experiment were made available by the Department of Entomology, Post Graduate Institute, MPKV, Rahuri.

Table 3.1 Details of different insecticides and biopesticides used in experiment

Sr. No.	Common name	Formulation	Trade name	Source
1	<i>Metarhizium anisopliae</i>	1.15 WP	Phule Metarhizium	Biocontrol Laboratory, Department of Agril. Entomology, MPKV, Rahuri
2	Azadirachtin	10000 ppm	Econeem	M/s. Margo Bio Controls Pvt. Ltd., Bangalore
3	Karanj oil	1 %	Saiee	Vijaya Agro Industries., Sangmaner.
4	Spinosad	45 % SC	Tracer	M/s. Dow Agro Sciences Pvt. Ltd.
5	Acephate	75 % SP	Asataf	M/s. Rallis India Ltd.
6	Flubendamide + Deltamethrin	8.33% + 5.56% SC	Fenos Quick	M/s. Bayer Crop Science Ltd., Mumbai
7	Spinetoram	11.7 EC	Delegate	M/s. Corteva Ltd.
8	Methyl eugenol	-	-	Rev Agro Services Pvt Ltd., Nashik
9	Wrapping foam bag	-	-	Rev Agro Services Pvt Ltd., Nashik

Table 3.2 Experimental details

1	Crop	Guava
2	Variety	Lucknow 49
3	Spacing	6.0 x 6.0 m
4	Replication	3
5	Treatment	9
6	Design	RBD (Randomized Block Design)

Table 3.3 Treatment details

Tr. No.	Treatment	Dose g or ml/ litre
T1	Wrapping of fruits	-
T2	Soil application of <i>Metarhizium anisopliae</i> 1.15 WP	10 kg/ha
T3	<i>Azadirachtin</i> 10000 ppm	3 ml
T4	Karanj oil 1 %	3 ml
T5	Spinosad 45 SC	0.4 ml
T6	Acephate 75 SP	1 g
T7	Flubendamide 8.33 % + Deltamethrin 5.56 % SC	0.5 ml
T8	Spinetoram 11.7 SC	0.5 ml
T9	Untreated control	-

3.3 Management of Guava Fruit Fly

Different treatments were tested for their Bio-efficacy against fruit fly on guava under field condition.

3.3.1 Preparation of Spray

The insecticidal spray solution for experimental site was freshly made every time just before commencement of the spraying activity.

Desired concentration of spray liquid was worked out by using following formula.

$$V = \frac{100}{a.i.} \times \text{recommended dose (g a.i./ha)}$$

Where,

V = Quantity required for spraying per hectare

a.i. =Active ingredient in commercial product

The appropriate quantities of insecticides were completely mixed with water according to spray concentration at the time of spraying and the solution was used for spraying.

3.3.2 Method of Spraying

Three trees were selected for each treatment. The insecticidal spray application initiated after the fruiting. The spray application was applied at an interval of 15 days. The spraying was carried out with help of sprayer and was replicated twice for each treatment.

3.3.3 Method of Recording the Observations

Three trees were selected from each plot for recording observations and marked with labels. The numbers of fruits infested by fruit flies were recorded from each tree. The observations were recorded at 3, 7 and 14 days after each spray application. Per cent fruit infestation was calculated by using formula:

$$\text{Per cent fruit damage (\%)} = \frac{\text{No. of infested fruits}}{\text{Total no. of fruits}} \times 100$$

3.4 Fruit Infestation

To evaluate efficacy of seven test insecticides, total fruit count was taken in treated as well as control plots. From the total fruits, infested and healthy fruits / plot were counted and computed to work out the per cent fruit damage. Observations on fruit yield also have been recorded to work out yield of guava with increase in yield over control and avoidable yield loss.

Per cent reduction over untreated control was calculated by using following formula:

$$\% \text{ reduction in fruit infestation} = \frac{\% \text{ Infestation in control} - \% \text{ fruit infestation in treatment}}{\% \text{ fruit infestation in control}} \times 100$$

The per cent increase in yield over control was calculated by using following formula:

$$\text{Yield increased over control (\%)} = \frac{T - C}{T} \times 100$$

Where,

T = Yield of respective treatment (q/ha)

C = Yield of control (q/ha)

3.5 Observation on Yield and Economics of Treatment

The data on yield of guava fruits obtained from different treatments were recorded separately at the time of each harvesting. Yield from a plot was converted to q/ha.

3.6 Statistical Analysis

Data on guava fruit fly and infested fruits due to fruit fly were transformed into arcsine transformed values and then subjected to statistical analysis. The standard error (SE) and critical difference (CD) at 5 % level of probability was calculated to determine efficacy of each treatment. Then subjected to statistical analysis for interpreting the results.

4. RESULTS AND DISCUSSION

Present investigation entitled, “Seasonal incidence and management of guava fruit fly *Bactrocera dorsalis* (Hendel)” was carried out at All India Coordinated Research Project on Fruits, Department of Horticulture, MPKV, Rahuri during January to September 2022. The results obtained are presented as under.

4.1 To Study Seasonal Incidence of Guava Fruit Fly

The data on incidence of guava fruit fly during January to September 2022 is presented in Table 4.1 and graphically depicted in Fig. 4.1.

Table 4.1 Seasonal incidence of guava fruit fly during January 2022 to September 2022

SWM	No. of fruit flies/trap/week	Temperature (°C)		Humidity (%)		Wind velocity (Km/Hr)	Rainfall (mm)
		Max	Min	RH (Morn.)	RH (Even.)		
5	6.8	28.7	12.1	82	24	0.8	0.0
6	5	27.3	13.2	81	33	1.5	0.0
7	5.5	29.2	14.4	80	30	0.7	0.0
8	7.5	33.0	16.1	79	23	1.0	0.0
9	8.8	33.1	18.1	55	21	0.6	0.0
10	8.6	32.3	19.7	73	30	1.4	0.0
11	11.66	35.7	21.1	59	18	2.0	1.4
12	13.33	77.6	22.5	55	16	2.1	0.0
13	15.33	78.1	22.3	55	14	1.8	0.0
14	15.33	39.7	23.4	52	12	1.9	0.0
15	15.5	38.9	24.5	59	17	2.2	0.0
16	15.66	38.8	24.9	52	16	1.9	0.0
17	16.33	39.4	27.5	45	17	2.0	0.0
18	46.83	39.9	26.4	50	17	3.2	0.0
19	57.16	40.9	28.1	50	21	3.6	0.0
20	52.66	39.1	27.0	60	23	4.9	1.6
21	86.66	37.5	27.0	61	25	5.9	0.0
22	74.16	38.3	26.3	65	25	6.0	0.0
23	67.83	38.1	26.0	65	31	3.8	8.6
24	70.5	35.8	26.2	72	39	3.4	9.0
25	85.83	33.4	24.9	80	52	3.5	96.6
26	90.33	31.1	24.3	84	58	2.3	58.2
27	103	30.5	23.9	84	63	4.4	15.2
28	114.83	22.2	23.4	89	80	2.4	37.6
29	118.33	29.3	24.0	85	63	4.5	7.4
30	123.16	29.1	23.5	97	55	2.4	68.4
31	132.33	30.7	23.5	89	62	1.0	120.0
32	144.66	28.3	24.1	84	71	3.1	56.2
33	155.66	28.3	24.1	81	70	5.4	2.6
34	172	29.8	24.1	81	64	4.0	1.6
35	204	31.6	23.2	87	54	1.5	23.8
36	172.33	30.8	23.5	90	65	1.3	5.0

From the data it was observed that, fruit fly incidence started from 5th standard meteorological week and lasted upto harvesting of fruits *i.e.* 36th standard meteorological week. Fruit fly population ranged from 6.8 to 204 fruit flies/trap/week during the experimental period.

Minimum fruit fly population was noticed during 5th standard meteorological week *i.e.* 4th week of January and it may be due to less influence of abiotic factors. Afterwards, population of guava fruit fly gradually increased from 18th standard meteorological week and reached to its peak during 35th standard meteorological week (204 fruit flies/trap/week) and it was started to decline during 36th standard meteorological week (172.33 fruit flies/trap/week).

At peak fruit fly population maximum, minimum temperature, morning and evening relative humidity, wind velocity and rainfall were 31.6°C, 23.2°C, 87 %, 54 %, 1.5 km/hr and 23.8 mm, respectively.

Results of present finding are in close conformity with Umesh *et al.* (2018) who noticed that maggot population of guava fruit fly, *Bactrocera* spp. started appearing from 29th SWM and reaching its maximum in 31st SMW. Results of present investigation are also in conformity with Shinde *et al.* (2021 a) who reported peak activity of fruit flies (98.33 fruit flies/trap/week) during 36th SMW.

4.2 Correlation Coefficient Between Weather Parameters and Incidence of Guava Fruit Fly during January to September 2022

The data pertaining to correlation coefficient between weather parameters and incidence of guava fruit fly is presented in Table 4.2. The data indicated that there was significant positive correlation between population of fruit flies with minimum temperature ($r=0.372^*$), morning humidity ($r=0.363^{**}$) and evening humidity (0.844^{**}), rainy days ($r=0.489^{**}$) as well as wind velocity ($r=0.359^*$). However, fruit fly incidence showed significant negative correlation with maximum temperature ($r=-0.400^*$).

The result of present findings are in line with Bansode (2009) who also reported, significant positive correlation between fruit fly incidence and minimum temperature, average temperatures, maximum relative humidity, minimum relative humidity, average relative humidity and rainy days, however, significant negative correlation with maximum temperature and sunshine hours.

Results of present investigation are in agreement with Shukla and Prasad (1985) and Singh (1998) who found significant positive correlation with temperature, relative humidity and rainfall in *B. dorsalis*.

Table 4.2 Correlation coefficient between weather parameters and incidence of guava fruit fly during January 2022 to September 2022

Weather Parameters	Correlation coefficient value (r)
Maximum temperature (°C)	-0.400*
Minimum temperature (°C)	0.372*
Morning relative humidity (%)	0.636**
Evening relative humidity (%)	0.844**
Wind velocity (Km/hr)	0.359*
Rainfall (mm)	0.511**
Number of rainy days	0.489**
*5% level of significance df 30 = 0.349	
**1% level of significance df 30 = 0.449	

4.3 Efficacy of Different Treatments Against Guava Fruit Fly during January 2022 to September 2022

The field efficacy of 3 biopesticides and 4 chemical insecticides was tested against guava fruit fly, *Bactrocera* spp. The different treatments viz. Wrapping of fruits, soil application of *M. anisopliae* 1.15 WP, azadirachtin 10000 ppm, karanj oil 1 %, spinosad 45 SC @ 150 g a.i /ha, acephate 75 SP @ 1 gm/L, flubendamide 8.83 % + deltamethrin 5.56 % SC @ 250 g a.i /ha, spinetoram 11.7 SC @ 56 g a.i /ha and untreated control were tested for their efficacy against guava fruit fly.

4.3.1 First Spray

Data on field efficacy of different treatments against guava fruit fly after first spray is presented in Table 4.3 and graphically illustrated in Fig. 4.2.

4.3.1.1 3 Days After Spray

From the data it was found that, per cent fruit damage varied from 4.67 to 38.33 per cent after first spray (Table 4.3). From the results it was noticed that, all the treatments were found significantly superior over untreated control and the treatment with wrapping of fruits was found promising in reducing fruit damage (3.67 %). However, amongst the tested treatments, spinosad 45 SC @ 0.4 ml/L was found next promising treatment against guava fruit fly with minimum fruit damage of (25.00 %) and it was followed by the treatment azadirachtin 10000 ppm @ 3 ml/L (26.00 %), spinetoram 11.7 EC @ 0.5 ml/L (26.67 %), acephate 75 SP 1gm/L (26.83 per cent) which were at par with each other. Next best treatment was flubendiamide 8.33 % + deltamethrin 5.56 % w/w SC @ 250 g a.i/ha

with 27.00 per cent fruit damage which was followed by the treatment with soil application of *Metarhizium anisopliae* @ 10 kg /ha (28.33 %) which were found at par with each other. Moreover, the treatment with karanj oil @ 3 ml/L and untreated control with maximum fruit damage of 28.33 and 38.33 per cent, respectively.

Table 4.3 Efficacy of different insecticides against guava fruit fly after first spray

Sr. No.	Treatments	Dose gm or ml	Fruit damage (%)		
			3 DAT	7 DAT	14 DAT
T1	Wrapping of Fruits	-	4.67 *(12.46)	3.67 (11.02)	3.33 (10.50)
T2	Soil application of <i>Metarhizium anisopliae</i> 1.15 WP	10 kg /ha	28.33 (32.04)	28.17 (31.94)	30.30 (33.50)
T3	Azadirachtin 10000 ppm	3 ml	26.00 (30.64)	26.00 (30.65)	28 (31.94)
T4	Karanj oil 1 %	3 ml	30.00 (39.50)	29.33 (39.04)	30.43 (33.42)
T5	Spinosad 45 SC	0.4 ml	25.00 (20.98)	22.67 (21.42)	25.30 (22.19)
T6	Acephate 75 SP	1 gm	26.83 (30.42)	27.17 (32.89)	27.33 (30.83)
T7	Flubendamide 8.83 + Deltamethrin 5.56 SC	0.5 ml	27.00 (30.28)	25.00 (29.25)	26.33 (25.30)
T8	Spinetoram 11.7 SC	1 ml	26.67 (31.08)	26.33 (30.86)	27.00 (30.98)
T9	Untreated Control	-	38.33 (39.90)	40.00 (39.74)	42.0 (39.69)
	S.E.(m) ±	-	3.11	2.92	2.68
	C.D. AT 5 %	-	9.15	8.75	7.35
	C.V	-	18.5	17.2	15.43

*Figures in parenthesis are arcsine transformed values, DAT- Days after treatment @ 5% of level of significance

4.3.1.2 7 Days After Spray

From the results, it was observed that per cent fruit damage due to fruit fly ranged from 3.67 to 42.00 per cent at seven days after first spray. All the treatments were

significantly superior over untreated control and the treatment with wrapping of fruits was found promising in reducing fruit fly damage (4.67 % fruit damage). However, next best treatment was spinosad 45 SC @ 0.4 ml/L (22.67 %) and it was followed by the treatment with flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (25.00 %) followed by azadirachtin 10000 ppm @ 3 ml/L (26.00 %) which were at par with each other. Next promising treatment was spinetoram 11.7 EC @ 0.5 ml/L with 26.33 per cent fruit damage and was followed by acephate 75 SP @ 1gm/L (27.17 %) followed by treatment with soil application of *M. anisopliae* @ 10 kg /ha (28.17 %) and were found at par with each other. Moreover, the treatment with karanj oil @ 3 ml/L (29.33 %) and untreated control (40.00 %) were the least effective treatments.

4.3.1.3 14 Days After Spray

From the results, it was noticed that, fruit damage due to guava fruit fly at fourteen days after first spray varied from 3.33 to 42.00 per cent (Table 4.3). All the treatments were significantly superior over untreated control and the treatment with wrapping of fruits was found promising in reducing fruit damage (3.33 %). However, it was followed by the treatment with spinosad 45 SC @ 0.4 ml/L (25.30 %). Next best treatment was flubendiamide 8.33 % + deltamethrin 5.56 % w/w SC @ 250 g a.i/ha (26.33 % fruit damage) which was followed by acephate 75 SP @ 1gm/L (27.33 % fruit damage), azadirachtin 10000 ppm @ 3 ml/L (28.00 %) and followed by treatment with soil application of *M. anisopliae* @ 10 kg /ha (30.30 %) at par with each other. Moreover, the treatments with karanj oil @ 3 ml/L (30.43 %) and untreated control (42.00 %) were the least effective treatments.

4.3.2 Second Spray

Data on field efficacy of different treatments against guava fruit fly after second spray is presented in Table 4.4 and graphically illustrated in Fig. 4.3.

4.3.2.1 3 Days After Spraying

From the results, it was found that per cent fruit damage ranged from 2.67 to 38.33 per cent at third days after second spray. All the treatments were significantly superior over untreated control and treatment with wrapping of fruits was found next promising treatment with minimum number of fruit fly damage (2.67 %). However, it was followed by spinosad 4 SC @ 0.4 ml/L (21.33 %) and it was followed by treatment with flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (25.27 %) followed by the treatment spinetoram 11.7 EC @ 0.5 ml/L (26.67 per cent), acephate 75 SP @ 1 gm/L (26.83 per cent) which were at par with each other. Next promising treatment azadirachtin

10000 ppm @ 3 ml/L (27.67 %) followed by treatment soil application of *M. anisopliae* @ 10 kg /ha (28.00 %) were found at par with each other. Moreover, the treatments with karanj oil @ 3 ml/L (30.33 %) and untreated control fruit damage of 30.33 and 38.33 per cent respectively.

Table 4.4 Efficacy of different insecticides against guava fruit fly after second spray

Sr. No.	Treatments	Dose gm or ml	Fruit damage (%)		
			3 DAT	7 DAT	14 DAT
T1	Wrapping of Fruits	-	2.67 *(9.36)	1.67 (7.33)	1.97 (8.06)
T2	Soil application of <i>Metarhizium anisopliae</i> 1.15 WP	10 kg /ha	28.00 (31.87)	22.00 (27.97)	22.33 (28.00)
T3	Azadirachtin 10000 ppm	3 ml	27.67 (30.64)	21.92 (27.91)	21.58 (27.67)
T4	Karanj oil 1 %	3 ml	30.33 (32.79)	28.00 (31.93)	28.67 (32.35)
T5	Spinosad 45 SC	0.4 ml	21.33 (17.50)	8.80 (17.62)	9.17 (17.62)
T6	Acephate 75 SP	1 gm	26.83 (30.36)	20.00 (26.56)	20.67 (27.04)
T7	Flubendamide 8.83 + Deltamethrin 5.56 SC	0.5 ml	25.27 (25.00)	19.82 (26.43)	20.59 (26.98)
T8	Spinetoram 11.7 SC	1 ml	26.67 (31.08)	21.17 (27.39)	21.33 (27.51)
T9	Untreated Control	-	38.33 (39.90)	44.67 (41.93)	45.00 (42.13)
	S.E.(m) ±	-	2.35	0.53	0.51
	C.D. AT 5 %	-	7.05	1.58	1.52
	C.V	-	15.43	12.40	15.34

*Figures in parenthesis are arcsine transformed values, DAT – Days After Treatment at 5% level of significance.

4.3.2.2 7 Days After Spray

From the results, it was observed that per cent fruit damage ranged from 1.67 to 44.67 per cent at seven days after second spray. All the treatments were significantly superior over untreated control and treatment with wrapping of fruits was found to be most effective treatment with minimum per cent of fruit damage (1.67 %). However, next promising treatment was spinosad 45 SC @ 0.4 ml/L (8.80 %), flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (19.82 %) followed by spinetoram 11.7 EC @ 0.5 ml/L (21.17 %), acephate 75 SP @ 1gm/L (20.00 %) which were at par with each other. Next promising treatment was azadirachtin 10000 ppm @ 3 ml/L (21.92 %) followed by treatment with soil application of *M. anisopliae* @ 10 kg /ha (22.00 %) and were found at par with each other. Moreover, karanj oil @ 3 ml/L (28.00 per cent) and untreated control (44.67 %) were the least effective treatments.

4.3.2.3 14 Days After Spray

From the results, it was noticed that, per cent fruit damage due to guava fruit fly ranged from 1.97 to 45.00 per cent at fourteen days after second spray. All the treatments were significantly superior over untreated control and the treatment with wrapping of fruits was found to be most effective treatment with minimum per cent damage (1.97 %). However, it was followed by the treatment with spinosad 45 SC @ 0.4 ml/L (9.17 %), treatment flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (20.59 %) followed by acephate 75 SP @ 1gm/L (20.67 %) spinetoram 11.7 EC @ 0.5 ml/L (21.33 %) were at par with each other. Next promising treatment was azadirachtin 10000 ppm @ 3 ml/L (21.58 %) followed by treatment with soil application of *M. anisopliae* @ 10 kg /ha (22.33 %) and were found at par with each other. Moreover, karanj oil @ 3 ml/L (28.67 %) and untreated control (45.00 %) were the least effective treatment.

4.3.3 Pooled Mean

Data pertaining to pooled mean due to bioefficacy of different treatments against guava fruit fly is presented in Table 4.5.

4.3.3.1 3 Days After Spray

The data on pooled mean number of guava fruit fly after spray revealed that, per cent fruit damage by guava fruit fly varied from 3.67 to 41.00 per cent at 3 days after spray (Table 4.5). From the results it was noticed that, all the treatments were found to be significantly superior over untreated control and treatment wrapping of fruits was found to be most effective treatment with minimum mean per cent of fruit damage of fruit fly (3.67%). However, it was followed by treatment spinosad 45 SC @ 0.4 ml/L with

minimum mean per cent fruit damage (9.17 %), treatment flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (20.59 %) followed by acephate 75 SP @ 1gm/L (20.67), spinetoram 11.7 EC @ 0.5 ml/L (21.33 %) which were at par with each other. Next promising treatment was azadirachtin 10000 ppm @ 3 ml/L (26.83 %) followed by treatment Soil application of *M. anisopliae* @ 10 kg /ha (28.16 %) respectively and were found at par with each other. Moreover, the treatment karanj oil @ 3 ml/L (30.16 %) and untreated control (41.00 %) were the least effective treatments.

Table 4.5 Efficacy of different insecticides against guava fruit fly (Pooled Mean)

Tr. No.	Treatments	Dose ml/gm	Fruit damage (%)			Pooled Mean	Mean % reduction over untreated control
			3 DAT	7 DAT	14 DAT		
T1	Wrapping of fruits	-	3.67 (11.04)	2.67 (9.40)	2.65 (9.37)	2.99 (9.94)	92.92
T2	<i>Metarhizium anisopliae</i> 1.15 WP	10 kg /ha	28.16 (32.05)	25.08 (30.05)	26.38 (30.90)	26.54 (31.00)	37.21
T3	Azadirachtin 10000 ppm	3 ml	26.83 (31.20)	23.96 (29.31)	24.79 (29.86)	25.19 (30.12)	40.40
T4	Karanj oil	3 ml	30.16 (33.31)	28.66 (32.37)	29.48 (32.89)	29.43 (32.85)	30.37
T5	Spinsad 45 SC	0.4 ml	23.16 (28.77)	15.73 (23.37)	17.23 (24.53)	18.70 (25.55)	55.76
T6	Acephate 75 SP	1 gm	26.83 (31.200)	23.58 (29.05)	24.00 (29.33)	24.80 (29.86)	41.32
T7	Flubendamide 8.83 + Deltamethrin 5.56 SC	0.5 ml	26.33 (30.87)	22.41 (28.25)	23.79 (29.19)	24.17 (29.44)	42.81
T8	Spinetoram 11.7 SC	1 ml	26.67 (31.09)	23.75 (29.17)	23.83 (29.22)	24.75 (29.83)	41.44
T9	Untreated Control	-	41.00 (39.82)	42.33 (40.49)	43.50 (41.27)	42.27 (40.56)	0
	S.E.(m) ±	-	3.11	2.92	2.68	0.08	-
	C.D. at 5%	-	9.34	8.75	8.04	0.25	-
	C.V		6.39	10.33	6.33	7.67	-

*Figures in parenthesis are arcsine transformed values, DAT – Days After Treatment

At 5 % level of significance.

4.3.3.2 7 Days After Spray

The data on pooled mean number of guava fruit fly after spray revealed that, per cent fruit damage by guava fruit fly varied from 2.67 to 42.33 per cent at seven days after spray (Table 4.5). From the results it was noticed that, all the treatments were found

to be significantly superior over untreated control and the treatment with wrapping of fruits was found to be most effective treatment with minimum mean per cent fruit damage (2.67%). However, it was followed by spinosad 45 SC @ 0.4 ml/L with minimum per cent of damage fruits (15.73 %), treatment flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (22.41 %) followed by acephate 75 SP @ 1gm/L (23.56 per cent), spinetoram 11.7 EC @ 0.5 ml/L 23.75 per cent were at par with each other. Next promising treatment was treatment which was azadirachtin 10000 ppm @ 3 ml/L (23.96 %) followed by treatment Soil application of *M. anisopliae* @ 10 kg /ha (25.08 %) and were found at par with each other. Moreover, karanj oil @ 3 ml/L (28.66 %) and untreated control (42.33 %) were the least effective treatments.

4.3.3.3 14 Days After Spray

The data on pooled mean number of guava fruit fly after spray revealed that, per cent fruit damage by guava fruit fly varied from 2.65 to 41.00 per cent at fourteen days after spray (Table 4.5). From the results it was noticed that, all the treatments were found to be significantly superior over untreated control and the treatment with wrapping of fruits was found to be most effective treatment with minimum mean per cent fruit damage (2.65%). However, it was followed by the treatment with spinosad 45 SC @ 0.4 ml/L with minimum mean per cent damage (17.23 %), treatment flubendamide 8.83% + deltamethrin 5.56 % SC @ 0.5 ml/L (23.79 %) followed by spinetoram 11.7 EC @ 0.5 ml/L (23.83 %), acephate 75 SP @ 1gm/L (24.00 %) were at par with each other. Next promising treatment azadirachtin 10000 ppm @ 3 ml/L (24.79 %) followed by treatment soil application of *M. anisopliae* @ 10 kg /ha (26.38 %) and were found at par with each other. Moreover, karanj oil @ 3 ml/Litre and untreated control (43.50 %) were the least effective treatment.

From the results of the pooled mean efficacy of treatments against guava fruit fly after spray revealed that, treatment with wrapping of fruits was found to be most effective treatment with minimum mean per cent damage of fruit fly (2.99 %). However, it was followed by spinosad 45 SC @ 0.4 ml/L with minimum mean per cent damage (18.70 %), flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (24.17 %) followed by spinetoram 11.7 EC @ 0.5 ml/L (24.75 %), acephate 75 SP @ 1gm/L (24.80 %) were at par with each other. Next promising treatment was azadirachtin 10000 ppm @ 3 ml/L (25.19 %) followed by treatment with soil application of *M. anisopliae* @ 10 kg/ha (26.54%) were found at par with each other. Moreover, karanj oil @ 3 ml/L (29.43 %) and untreated control (42.27 %) were the least effective treatment. Similar results were discussed by Mondal *et al.* (2015) that fruit fly infestation varied between 1.32 % and

17.31% in all treatments using wrapping materials and 13.14% in case of combined use of pheromone trap (Bacu-lure) and Dichlorvos spray as compared to 21.71% in sole use of Dichlorvos and 66.67% in control plots.

Mitra *et al.* 2008 advocated various management options including use of hydrolyzed protein and sugar spray, pheromone trap, spraying of botanicals and chemical insecticides, field sanitation, poison food trap and bagging of fruits for management of fruit fly. Among these, bagging or wrapping the fruits has been found more practicable in guava.

Similar results given by Singh *et al.* 2007, Bagging is a superior option of fruit fly management over conventional practice of pesticide spray for its' efficacy and zero pesticidal residue in the fruit. Guava fruits bagged with biodegradable poly-films, 6-9 weeks before harvesting, effectively controlled fruit fly (*Anastrepha spp.*) and guava weevil (*Conotrachelus psidii*) (Bilck *et al.*, 2011). Bagging not only keeps the female flies away from the fruits but also improves the texture, colour and quality of the fruits.

In respect of Spinosad, the findings are in confirmation with that reported by Shivangi *et al.* (2017) and Shinde *et al.* (2018). Findings in respect of Azadirachtin and NSE are in confirmation with that reported by Shivangi *et al.* (2017). Present investigation in conformity with Firake *et al.* 2013 evaluated that treatment with *Metarhizium anisopliae* @ 5 kg/ha to the soil underneath the tree canopy reduced fruit flies.

Also Sookar *et al.* (2014) reported that infection by *M. anisopliae* resulted in the reduction of the number of eggs produced by females of fruit fly. Narayanamma (2013) reported that spraying with spinosad recorded less per cent damage by fruit borer and resulted in high yield in guava.

Data on mean per cent reduction over untreated control (Table 4.5) showed that, the treatment with wrapping of fruits was recorded highest of 92.92 per cent reduction in average survival population over untreated control. However, it was followed by the treatment with spinosad 45 SC @ 0.4 ml/L (55.76 per cent), treatment flubendamide 8.83% + deltamethrin 5.56 % SC @ 0.5 ml/L (42.81 per cent) followed by the treatment acephate 75 SP @ 1gm/L (41.32 per cent), spinotoram 11.7 EC @ 0.5 ml/L (41.44 per cent) were at par with each other. Next promising treatment was azadirachtin 10000 ppm @ 3 ml/L (40.40 per cent) followed by treatment Soil application of *M. anisopliae* @ 10 kg /ha (37.21 per cent) and were found at par with each other. Moreover, karanj oil @ 3 ml/L recorded (30.37 per cent reduction over control) and untreated control (42.27 per cent reduction over control) were the least effective treatment.

Table 4.6 Effect of different treatments on yield of guava during January to September 2022

Tr. No.	Treatments	Dose ml/gm	Marketable fruit yield (q/ha)	Per cent increase over control
T1	Wrapping of fruits	-	243.00	88.00
T2	<i>Metarhizium anisopliae</i> 1.15 WP	10 kg /ha	170.00	15.00
T3	Azadirachtin 10000 ppm	3 ml	195.00	40.00
T4	Karanj oil 1 %	3 ml	167.00	12.00
T5	Spinosad 45 SC	0.4 ml	242.00	87.00
T6	Acephate 75 SP	1 gm	205.00	50.00
T7	Flubendamide 8.83 + Deltamethrin 5.56 SC	0.5 ml	212.00	57.00
T8	Spinetoram 11.7 SC	1 ml	200.00	45.00
T9	Untreated Control	-	155.00	-
	S.E.(m) ±	-	0.61	-
	C.D. at 5%	-	1.84	-

Data pertaining to marketable fruit yield of guava is presented in Table 4.6 and graphically illustrated in Fig. 4.4. Data indicates that, the yield obtained from all treatments ranges between 243 to 155 q/ha. Among the various treatments, significant highest marketable fruit yield (243 q/ha) was harvested with treatment wrapping of fruits, followed by treatment flubendamide 8.83 % + deltamethrin 5.56 % SC @ 05 ml (242 q/ha). The next best treatments yield wise were acephate 75 SP @ 1gm/L (205 q/ha), spinetoram 11.7 EC @ 0.5 ml/L (200 q/ha), azadirachtin 10000 ppm @ 3 ml/L (195 q/ha), *M. anisopliae* @ 10 kg /ha (170 q/ha) were at par with each other. The treatment karanj oil 3 ml/L recorded 167 q/ha and untreated control recorded 155.00 q/ha fruit yield of guava.

5. SUMMARY AND CONCLUSION

The present investigations were carried out for studying the Seasonal incidence and management of guava fruit fly *Bactrocera dorsalis*, at MPKV, Rahuri during January to September 2022. Summary of research findings and the conclusions drawn are presented below.

5.1 Summary

5.1.1 To Determine Seasonal Dynamics of Guava Fruit Fly

From the data it was observed that fruit fly incidence started from 5th standard meteorological week and lasted upto harvesting of fruits *i.e.* 36th standard meteorological week. Fruit fly population ranged from 6.8 to 204 fruit flies/trap/week during the experimental period.

Minimum population of fruit flies was noticed during 5th standard meteorological week *i.e.* 4th week of January and it may be due to less influence of abiotic factors. Afterwards, population of guava fruit fly gradually increased from 18th standard meteorological week and reached at peak level on 35th standard meteorological week (204 fruit flies/trap/week) and it was suddenly declined during 36th standard meteorological week (172.33/trap). At peak level of fruit fly, maximum and minimum temperature was 31.6°C and 23.2°C, morning relative humidity was 87 per cent during 35th meteorological week.

The data pertaining to correlation between incidence of guava fruit fly with weather parameters is presented in Table 4.2. The data indicated that there was significant positive correlation between population of fruit flies with minimum temperature ($r = 0.372^*$), morning humidity ($r = 0.363^{**}$) and evening humidity (0.844^{**}), rainy days ($r = 0.489^{**}$) as well as wind velocity ($r = 0.359^*$). However, fruit fly incidence significant negative correlation with maximum temperature ($r = - 0.400^*$).

5.1.2 Efficacy of Different Treatments Against Guava Fruit Fly

From the results of the pooled mean efficacy of treatments against guava fruit fly after spray revealed that, treatment with wrapping of fruits was found to be most effective treatment with minimum mean per cent damage of fruit fly (2.99 %). However, it was followed by spinosad 45 SC @ 0.4 ml/L with minimum mean per cent damage (18.70 %), flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (24.17 %) followed by spinetoram 11.7 EC @ 0.5 ml/L (24.75 %), acephate 75 SP @ 1 gm/L (24.80 %) were at par with each other. Next promising treatment was azadirachtin 10000 ppm @ 3 ml/L

(25.19 %) followed by treatment with soil application of *M. anisopliae* @ 10 kg /ha (26.54%) were found at par with each other. Moreover, karanj oil @ 3 ml/L (29.43 %) and untreated control (42.27 %) were the least effective treatment.

Data on mean per cent reduction over untreated control (Table 4.5) showed that the treatment with wrapping of fruits was recorded highest of 92.92 per cent reduction in average survival population over untreated control. However, it was followed by the treatment with spinosad 45 SC @ 0.4 ml/L (55.76 %), treatment flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (42.81 %) followed by the treatment acephate 75 SP @ 1 gm/L (41.32 %), spinetoram 11.7 EC @ 0.5 ml/L (41.44 %) were at par with each other. Next promising treatment was azadirachtin 10000 ppm @ 3 ml/L (40.40%) followed by treatment Soil application of *M. anisopliae* @ 10 kg /ha (37.21 %) and were found at par with each other. Moreover, karanj oil @ 3 ml/L recorded (30.37 per cent reduction over control) and untreated control (42.27 per cent reduction over control) were the least effective treatment.

5.1.3 Effect of Different Treatments on Yield of Guava during January 2022 to September 2022

Data pertaining to marketable fruit yield of guava is presented in Table 4.6 and graphically illustrated in Fig. 4.4. Data indicates that, the yield obtained from all treatments ranges between 243 to 155 q/ha. Among the various treatments, significant highest marketable fruit yield (243 q/ha) was harvested with treatment wrapping of fruits, followed by treatment flubendamide 8.83 % + deltamethrin 5.56 % SC @ 05 ml (242 q/ha). The next best treatments yield wise were acephate 75 SP @ 1 gm/L (205 q/ha), spinetoram 11.7 EC @ 0.5 ml/L (200 q/ha), azadirachtin 10000 ppm @ 3 ml/L (195 q/ha), *M. anisopliae* @ 10 kg /ha (170 q/ha) were at par with each other. The treatment karanj oil 3 ml/L recorded 167 q/ha and untreated control recorded 155.00 q/ha fruit yield of guava.

5.3 Conclusion

From the study, it can be concluded that

1. The fruit fly incidence started from 5th meteorological week (6.8 fruit flies/trap/tree and lasted upto the harvesting of the crop *i.e.* 36th standard meteorological week (172.33 flies/trap/week). Highest population of observed during 35th standard meteorological week *i.e.* 4th week of August (204 flies/trap/week).
2. From the correlation study it was revealed that, average number of fruit flies trapped in methyl eugenol trap showed significant negative correlation with maximum temperature ($r=-0.400^*$). The minimum temperature (T min.) showed

positive correlation with average number of fruit flies in methyl eugenol trap ($r=0.372^*$).

3. From the bioefficacy study, it was found that treatment with wrapping of fruits was found to be most effective treatment with minimum fruit damage (2.99%). However, it was followed by the treatment with spinosad 45 SC @ 0.4 ml/L with minimum mean fruit damage (18.70%) treatment flubendamide 8.83 % + deltamethrin 5.56 % SC @ 0.5 ml/L (24.17 %) followed by the treatment spinetoram 11.7 EC @ 0.5 ml/L (24.75 %), acephate 75 SP @ 1 gm/L (24.80 %) were at par with each other. Next promising treatment was treatment which was azadirachtin 10000 ppm @ 3 ml/L (25.19%) followed by treatment with soil application of *M. anisopliae* @ 10 kg /ha (26.54 %) respectively and were found at par with each other. Moreover, the treatments with karanj oil @ 3 ml/L (29.43 %) and untreated control (42.27 %) were the least effective treatment.

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7. APPENDICES

Appendix I : Weekly mean weather data during January to September 2022

Standard meteorological week	Temperature (°C)		Humidity (%)		Wind Velocity (Km/Hr)	Rainfall (mm)	No. of Rainy Days
	Max	Min	RH-I	RH-II			
5	28.7	12.1	82	24	00.8	000.0	-
6	27.3	13.2	81	33	01.5	000.0	-
7	29.2	14.4	80	30	00.7	000.0	-
8	33.0	16.1	79	23	01.0	000.0	-
9	33.1	18.1	55	21	00.6	000.0	-
10	32.3	19.7	73	30	01.4	000.0	-
11	35.7	21.1	59	18	02.0	001.4	-
12	77.6	22.5	55	16	02.1	000.0	-
13	78.1	22.3	55	14	01.8	000.0	-
14	39.7	23.4	52	12	01.9	000.0	-
15	38.9	24.5	59	17	02.2	000.0	-
16	38.8	24.9	52	16	01.9	000.0	-
17	39.4	27.5	45	17	02.0	000.0	-
18	39.9	26.4	50	17	03.2	000.0	-
19	40.9	28.1	50	21	03.6	000.0	-
20	39.1	27.0	60	23	04.9	001.6	-
21	37.5	27.0	61	25	05.9	000.0	-
22	38.3	26.3	65	25	06.0	000.0	-
23	38.1	26.0	65	31	3.8	008.6	1
24	35.8	26.2	72	39	3.4	009.0	2
25	33.4	24.9	80	52	3.5	096.6	4
26	31.1	24.3	84	58	2.3	058.2	5
27	30.5	23.9	84	63	4.4	015.2	2
28	22.2	23.4	89	80	2.4	037.6	6
29	29.3	24.0	85	63	4.5	007.4	1
30	29.1	23.5	97	55	2.4	068.4	2
31	30.7	23.5	89	62	1.0	120.0	3
32	28.3	24.1	84	71	3.1	056.2	4
33	28.3	24.1	81	70	5.4	002.6	-
34	29.8	24.1	81	64	4.0	001.6	-
35	31.6	23.2	87	54	1.5	023.8	1
36	30.8	23.5	90	65	1.3	05.0	5.0

8. VITAE

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AGRICULTURAL ENTOMOLOGY
2023

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