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Efficacy of Different Biopesticides and Insecticides against Guava Fruit Fly (*Bactrocera dorsalis* Hendel)

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Abstract
The present investigation entitled "Efficacy of Different Biopesticides and Insecticides against Guava Fruit Fly (*Bactrocera dorsalis* Hendel)" was carried out at Horticulture Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, during the *Kharif*, 2024. The overall mean fruit damage values after first and second spray confirmed the superior efficacy of Spinosad 45% SC, which recorded the lowest fruit damage of (19.18%). It was followed by T_6: Spinetoram 11.7 SC with (21.22%) fruit damage and T_2: Lambda-cyhalothrin5% EC with 23.60 per cent fruit damage. Moderate levels of control were observed in biopesticide treatments, such as T_5: *Azadirachtin* 10000 PPM with 27.16 per cent fruit damage, T_3: *Metarhizium anisopliae* with 28.23 per cent, and T_1: *Beauveria bassiana* with 29.83 per cent fruit damage. The highest pooled mean fruit damage was recorded in the untreated check (T_7), which recorded 43.57 per cent.

Keywords: Guava fruit fly, *Bactrocera dorsalis*, biopesticides, insecticides, Spinosad, Spinetoram

Introduction

India is one of the world's leading countries in fruit production. A diverse range of fruits is grown throughout the nation, such as apples, pomegranates, bananas, guavas, and sapota. Guava (*Psidium guajava* L.) is a small tropical tree or shrub belonging to the *Myrtaceae* family and is cultivated for its edible fruit. Native to tropical America, guava trees are cultivated in tropical and subtropical regions around the globe. They have a chromosome number of 2n = 18, while seedless varieties possess a chromosome count of 2n = 33. The *Myrtaceae* family, commonly referred to as the Myrtle family, includes dicotyledonous plants classified within the order Myrtales (Hinwar, 2013) [6].

In India, guava has gained significant recognition over the years and is now counted among the seven major fruit crops grown in the country. It encompasses an area of 3.58 lakh hectares in India, yielding an annual production of 52.63 lakh MT (Anonymous, 2024a) [1]. The fruit is grown in several states including Uttar Pradesh, Bihar, Madhya Pradesh, Chhattisgarh, Odisha, West Bengal, Maharashtra, Andhra Pradesh, Haryana, Gujarat, Rajasthan, and Punjab. Uttar Pradesh stands out as the top state for both area and production of guava, followed by Madhya Pradesh and Bihar, while Punjab excels in productivity. In Rajasthan, it is extensively cultivated, occupying an area of 12450 ha and resulting in an annual output of 150500 MT (Anonymous, 2024b) [2].

Guava is affected by many insect pests which can cause an adverse effect on both the quality and quantity of guava fruits. Guava trees are affected by more than 80 species of insects and mites. However, only a few of them have been noted as regularly occurring and causing serious damage (Butani, 1974) [47]. The major insect pests are fruit flies (*Bactrocera* spp.), mealybugs (*Ferrisia virgata*), bark eating caterpillars (*Inderbella quadrinotata.*), scale insects (*Chloropulvinaria psidi* Mask) and stem borer (*Batocera rufomaculata* and *Aristobia testudo*). Some minor pests *viz*., aphids (*Aphis gossypii*), fruit borer (*Deudorix Isocrates* Fabricus), spiraling whitefly (*Aleurodicus disperses* Russell), mites (*Brevipalpus phoenicis* Geijskes and *Eutetranychus orientalis* Klein), thrips (*Rhipiphorothrips cruentatis* Hood), leaf eating beetles/ weevils and shoot borer are also reported on guava.

The fruit fly is a significant pest of guava and belongs to the *Terphritidae* family, which is one of the largest and most diverse families within the Diptera order. The *Tephritidae* family encompasses around 4000 species categorized into 500 genera (White and Elson-Harris, 1992) [16]. Fruit flies are known to infest a variety of fruits and vegetable crops in both Tropical and Sub-Tropical Regions. Approximately 35 per cent of the identified fruit fly species target soft fruits, with significant ones being guava, mango, citrus, peach, ber, and numerous cucurbitaceous vegetables (White and Elson-Harris, 1992) [16]. These fruit flies have a widespread distribution and are a major hindrance to the production of guava during the rainy season. The female fruit fly uses her ovipositor to puncture the fruit and lays her eggs in clusters. As a result, dark puncture marks are visible due to the oviposition. Subsequently, pathogenic organisms such as bacteria and fungi can enter the fruit through the oviposition punctures, leading to rotting. Consequently, the mesocarp becomes contaminated, and eventually, the fruits drop prematurely. The fruit fly, *Bactrocera dorsalis* is the major pest of guava which causes 20 to 30 per cent loss. Infestation of the fruit fly ranged from 20.00 to 46.00 per cent with crop loss 16 to 40 per cent (Singh *et al*., 2007; Hasseb, 2007) [13, 5].

Plant protection in India and in most of the developing countries is mainly based on the use of chemical pesticides. The management of guava fruit fly using biopesticides is increasingly preferred over synthetic insecticides for several important reasons. Unlike synthetic insecticides, which often leave harmful chemical residues on fruits, biopesticides degrade rapidly, ensuring minimal residue levels and promoting food safety, which is crucial for both domestic consumption and export markets. Moreover, the excessive use of synthetic chemicals has led to the development of resistance in many insect pest populations, including fruit flies. Biopesticides, with their varied and novel modes of action, help in delaying resistance development and maintaining long-term pest control efficacy (Sparks *et al.*, 2012) [15]. Therefore, there is a need to identify an alternate toxicant that can provide effective management of fruit flies and which does not cause any problems in or on the fruits.

Materials and Methods

The field experiment was conducted at Horticulture farm, Rajasthan College of Agriculture, MPUAT, Udaipur to study the efficacy of different biopesticide and insecticides against guava fruit fly during *Kharif*, 2024. The experiment was laid out in a randomized block design having seven treatments and three replications. The treatments were applied after the insect reached EIL. Doses of the respective treatments used is mentioned below in Table 3.2.

Table 1.1: Field experiment details

1.	Location of Experiment	Horticulture farm, Rajasthan College of Agriculture, MPUAT, Udaipur
2.	Season and year	*Kharif*, 2024
3.	Crop	Guava
4.	Age of tree	5 year
5.	Spacing	6m x 6m
6.	Treatments	7
7.	Replication	3
8.	Design	RBD

Table 1.2: Details of Treatment

S. No.	Treatments	Dosage
T_1	*Beauveria Bassiana* 2% WP	20gm/litre of water
T_2	Lambda-cyhalothrin 5% EC	1ml/litre of water
T_3	*Metarhizium anisopliae* 1.5WP (Soil application)	10kg/ha.
T_4	Spinosad 45% SC	0.4ml/litre of water
T_5	Azadirachtin 10000PPM	3ml/litre of water
T_6	Spinetoram 11.7SC	0.5ml/litre of water
T_7	Untreated check	

Observation recorded

Three trees was selected from each plot for recorded observations and marked with labels. The observations was recorded day before spray and 3rd, 7th and 14th days after each spray application. Total number of healthy and infested fruits were counted to observe percentage infestation by the following formula:

$$\text{Per cent fruit infestation (\%)} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits}} \text{ X } 100$$ (Khan *et al*. 2017) [8]

Statistical analysis

Data on guava fruit fly and infested fruits due to fruit fly were transformed into arcsine transformed values and presented in parenthesis. The data were statistically analyzed by using standard analysis of variance as suggested by Gomez and Gomez (1984).

Results

First Spray

The information shown in table 1.3 reveals that the percentage of fruit damage ranged from 23.43 to 35.03 percent following the first spray. The findings indicate that all treatments significantly outperformed the untreated control, with Spinosad 45% SC demonstrating the most effectiveness in minimizing fruit damage (23.43%). Notably, Spinetoram 11.7 SC emerged as the second most effective treatment against guava fruit fly, resulting in a minimum fruit damage rate of (25.33%), and both Spinosad and Spinetoram yielded comparable results. This was followed by Lambda-cyhalothrin5% EC, which recorded a fruit damage rate of (27.47%). Among the biopesticide options, *Azadirachtin* at 10000 ppm, used at a rate of 3 ml/L, showed the best performance with (28.67%) fruit damage. This was succeeded by *M. anisopliae* %1.15 WP, with a fruit damage percentage of (29.27%), while the least effective treatment was *Beauveria bassiana* 2% WP, exhibiting (30.73%) fruit damage. The highest percentage of fruit damage was observed in the untreated control, at (35.37%).

Seven days after the initial spray, the percentage of fruit damage caused by fruit flies varied between (18.87%) and (38.07%). All treatment methods showed significant effectiveness compared to the untreated control, with Spinosad 45% SC emerging as the most effective in minimizing fruit damage (18.87%). Among the treatments evaluated, Spinetoram 11.7 SC also proved to be effective against guava fruit flies, showing a fruit damage level of (21.13%), with both treatments being statistically comparable. Following closely was the Lambda-cyhalothrin 5%EC treatment, which resulted in a (23.76%) fruit damage rate. Among the biopesticide options, *Azadirachtin* 10000 ppm at a dosage of 3 ml/L was the most effective, leading to (26.27%) fruit damage. The least effective option was *Beauveria bassiana* 2% WP, which recorded a (29.86%) fruit damage rate. The highest percentage of fruit damage was observed in the untreated control group, at (38.07%).

The data presented indicates that the treatment with Spinosad 45% SC resulted in the lowest percentage of fruit damaged (21.87%). Among the tested treatments, Spinetoram 11.7 EC was identified as the next most effective option against guava fruit fly, with a fruit damage rate of (23.47%), and both treatments were comparable to each other. This was followed by Lambda-cyhalothrin 5% EC, which resulted in (25.60%) fruit damage. Among the biopesticide treatments, *Azadirachtin* 10000 ppm at a rate of 3 ml/L have (28.23%) fruit damage, while *M. anisopliae*1.15 %WP resulted in (29.30%) fruit damage, and the least effective treatment was *Beauveria bassiana* 2% WP with (30.86%0 damage. Conversely, the untreated control exhibited a consistent rise in fruit damage over the same timeframe, increasing to (42.68%) at the 14th day.

Second Spray

The data indicated in table 1.3 revealed that, after three day of spray, it was observed that the percentage of fruit damage ranged from (19.06%) to (45.68%) on the third day following the second spray. All treatments showed significant improvement compared to the untreated control, with Spinosad 45 SC being the most effective in minimizing fruit damage (19.06%). Following closely, Spinetoram 11.7 %EC emerged as the next best treatment against guava fruit fly, resulting in a minimum fruit damage of (21.13%), and both treatments were statistically similar. This was succeeded by the lambda-cyhalothrin 5% EC treatment (23.27%). Among the biopesticide treatments, *Azadirachtin* 10000 ppm at 3 ml/L proved to be the most effective with (27.20%) fruit damage. This was followed by *M. anisopliae* 1.15 %WP, which resulted in 28.15 per cent fruit damage, while the least effective treatment was *Beauveria bassiana* 2% WP, which showed 29.27 percent fruit damage. The highest percentage of fruit damage was noted in the untreated control group (45.68%).

On the seven day after spray percentage of fruit damage caused by the fruit fly ranged from (14.73%) to (47.68%). Each treatment was significantly more effective than the untreated control, with Spinosad 45% SC emerging as the most effective in minimizing fruit damage at (14.73%). Following closely, Spinetoram 11.7 SC also proved effective against the guava fruit fly, exhibiting a minimum fruit damage of (16.80%), and both treatments were statistically similar. The lambda-cyhalothrin 5%EC treatment resulted in a fruit damage percentage of (19.60%). Among the biopesticide treatments, *Azadirachtin* 10000 ppm at 3 ml/L stood out with a fruit damage rate of (25.53%). The least effective treatment was *Beauveria bassiana* 2% WP, which showed a fruit damage percentage of (28.46%). The highest percentage of fruit damage was noted in the untreated control group, at (47.68%).

After fourteen day of application Spinosad 45% SC exhibited the lowest percentage of fruit damage, recorded at (17.09%). Among the tested treatments, Spinetoram 11.7 EC was found to be the next most effective against guava fruit fly, causing a fruit damage of (19.47%), with both treatments showing similar effectiveness. This was followed by Lambda-cyhalothrin 5% EC, which resulted in (21.93%) fruit damage. Regarding biopesticide treatments, *Azadirachtin* 10000 ppm at 3 ml/L caused (27.07%) fruit damage, while *M. anisopliae* 1.15 WP led to (28.01%) fruit damage and *Beauveria bassiana* 2% WP was the least effective, resulting in 29.79 percent fruit damage. Conversely, the untreated control displayed a consistent increase in fruit damage over the same period, reaching (52.30%) at 14 DAT.

Discussion

A field study was conducted to evaluate the efficacy of various insecticide and biopesticides treatments against guava fruit fly (*Bactrocera dorsalis*). Pre-treatment observations confirmed uniform infestation levels across all treatments (28.10%-31.81%). Following the first and second sprays, all treatments significantly reduced fruit fly damage compared to the untreated control. Among them, Spinosad 45% SC consistently demonstrated the highest efficacy, recording the lowest fruit damage at 3, 7, and 14 days after each spray. It was closely followed by Spinetoram 11.7 SC and Lambda-cyhalothrin 5% EC. Biopesticide treatments showed moderate effectiveness, with *B. bassiana* being the least effective.

The present findings are closely associated with findings of Khan *et al.* (2017) [8] who reported that spray of Spinosad was found to be most effective reducing the average fruit fly infestation to 6% and 6.3% for the year 2013 and 2014 respectively with cost benefit ratio of 1: 14.7. Similarly, Hirekurubar *et al.* (2018) [7] reported 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 %). Shinde *et al.* (2021) [11] 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 %) and the next best treatments was *Azadirachtin* 10000 ppm (25.21 %). In respect of Spinosad, the findings are in confirmation with that reported by Shivangi *et al.* (2017) [12] and Shinde *et al.* (2018). Findings in respect of *Azadirachtin* and NSE are in confirmation with that reported by Shivangi *et al.* (2017) [12]. Present investigation in conformity with Firake evaluated that treatment with *Metarhizium anisopliae* @ 5 kg/ha to the soil underneath the tree canopy reduced fruit flies. Also, Sookar *et al.* (2014) [14] reported that infection by *M. anisopliae* resulted in the reduction of the number of eggs produced by females of fruit fly. Narayanamma (2013) [9] reported that spraying with Spinosad recorded less per cent damage by fruit borer and resulted in high yield in guava.

Similarly, Saini *et al.* (2024) [10] reported that among various insecticides/ botanicals tested for their efficacies, Chlorantraniliprole (0.005%), Cyantraniliprole (0.002%), Spinosad (0.004%) were found quite effective for the management of fruit fly on guava.

Table 1.3: Efficacy of different biopesticides and insecticides against guava fruit fly

	Treatments	Dose		Fruit infestation (%) after 1st spray			Fruit infestation (%) after 2nd spray			Overall mean
			DBS	3DAT	7DAT	14DAT	3DAT	7DAT	14DAT	
T_1	*Beauveria Bassiana* 2% WP	20gm/lit	31.36	30.73 (33.66)*	29.86 (33.12)	30.86 (33.73)	29.27 (32.74)*	28.46 (32.22)	29.79 (33.06)	29.83 (33.10)
T_2	Lambda-cyhalothrin 5%EC	1ml/lit	29.71	27.47 (31.60)	23.76 (29.14)	25.60 (30.40)	23.27 (28.83)	19.60 (26.26)	21.93 (27.92)	23.60 (29.06)
T_3	*Metarhizium anisopliae* 1.5WP (Soil application)	10kg/ha.	30.34	29.27 (32.73)	27.83 (31.82)	29.30 (32.76)	28.15 (32.03)	26.81 (31.18)	28.01 (31.95)	28.23 (32.09)
T_4	Spinosad 45%SC	0.4ml/lit	28.10	23.43 (28.93)	18.87 (25.71)	21.87 (27.88)	19.06 (25.88)	14.73 (22.51)	17.09 (24.40)	19.18 (25.95)
T_5	*Azadirachtin* 10000PPM	3ml/lit	29.78	28.67 (32.36)	26.27 (30.82)	28.23 (32.08)	27.20 (31.42)	25.53 (30.34)	27.07 (31.34)	27.16 (31.41)
T_6	Spinetoram 11.7SC	0.5ml/lit	29.14	25.33 (30.22)	21.13 (27.35)	23.47 (28.95)	21.13 (27.35)	16.80 (24.12)	19.47 (26.14)	21.22 (27.42)
T_7	Untreated check	-	31.81	35.03 (36.28)	38.07 (38.09)	42.68 (40.79)	45.68 (42.52)	47.68 (43.67)	52.30 (46.32)	43.57 (41.31)
S.Em±			1.45	0.84	0.90	0.76	0.76	1.06	0.85	0.61
CD @ 0.05			4.47	2.59	2.78	2.35	2.36	3.29	2.36	1.89

*Figures in parenthesis are arcsine transformed values, DBS-Damage before spray, DAT-Days after treatment at 5% level of significance

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