Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(2): 135-138

Received: 20-01-2017
Accepted: 21-02-2017

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Integrated pest management of fruit flies in guava orchards

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Abstract
The study was carried out to devise moth effective and economical integrated pest management strategy against fruit flies in guava orchards. The experiment was laid out in randomized complete block design with three replication and eight treatments including the control. 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 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, followed by the of hoeing and sanitation alongwith the spray Diptrex 80% WP @ 150 gm / 100 liter of water (CBR= 1: 14.85). Hoeing under tree canopy alone proved to be least effective with average fruit fly infestation 16.67% and 15.85% for the year 2013 and 2014 respectively with lowest CBR.

Keywords: Fruit fly, guava, hoeing, baits, Diptrex and sanitation

1. Introduction
Fruit flies (Diptera: Tephritidae) are among the most economically important pests attacking fruits found everywhere in the world [1]. The most economically significant fruit fly genus Bactrocera Macquart, comprises 651 described species with at least 50 species considered to be important pests, many of which are highly polyphagous [2,3]. These constitute enormous threats to production attacking a wide range of fruits and fleshy vegetables throughout tropical and sub-tropical areas [4] causing both quantitative and qualitative losses. Furthermore, due to their susceptibility to invasive tephritid species, many fruit-producing countries have imposed quarantine restrictions on the import of products from countries infested with particular fruit fly species, and/or require that fruits and vegetables undergo quarantine treatment before their importation is allowed [5]

The damage reported by the fruit flies species, *B. zonta* range from 5 to 100% in Pakistan [6].Most of damage is caused by the larvae, which feed inside the fruit during their growth and development [7]. Since the damage done in fruit and vegetables is internal, and therefore difficult to control by the use of a single control measure [8].

The practice of integrated pest management (IPM) is important because of its effectiveness and gains for the environment and health; otherwise the use of pesticides will keep increasing [9]. According to Verghese *et al*. [10], the practice of IPM to control *B. dorsalis* can give very high reductions of infestation. The array of control methods ranged from insecticide sprays to foliage and soil, bait-sprays, male annihilation techniques, releases of sterilized flies and parasitoids, and cultural controls can be used.

In practice, implementation of IPM programs targeting fruit flies should be based on a particular crop/pest/environment scenario, IPM goals, e.g., temporal/spatial scales for implementation, knowledge of pest ecology and natural enemies, as well as knowledge of socio-economic factors [11].

The present study was conducted to device an effective IPM program targeting fruit flies on guava, the preferred food host of fruit fly [12] using various cultural, chemical and mechanical control methods like sanitation, soil disturbance and insecticide sprays and baits keeping in view the economics of treatments and there effects on yield of the trees.

2. Materials and Methods
The guava orchards of Ayub Agricultural Research Institute, Faisalabad were used in this study for the year 2013 and 2014. The experiment was laid out in randomized complete block design using eight treatments including check.

After every 10 days intervals from the month of April to October the removal of fallen fruits was carried out, and these were buried deep in the soil. The methyl eugenol traps @ 5 traps/ acre were installed in combination with hoeing under the tree canopy. The installation of pheromone traps continue from March to November and lures were replaced at fortnight intervals. Hoeing under the tree canopy was done at 15 days intervals from March to October. Spray of insecticide was carried out on the appearance of the pest and repeated at 15 days interval from May to August. When used in integrated manner all the operations were carried out as per their requirements described above.

Table 1: Treatments for the IPM of guava

Sr. No	Treatments
T1	Hoeing @ 15 days interval
T2	Hoeing @ 15 days interval + sanitation (collection of fallen fruits and burying deep in the soil) @ 10 days interval
T3	Hoeing @ 15 days interval + pheromone (methyl eugenol) traps @ 5 traps/ acre
T4	Spray of Diptrex 80 WP @ 150 ml/ 100 lit. of water
T5	Hoeing + sanitation + Diptrex spray
T6	Hoeing @ 15 days interval+ sanitatation @ 10 days interval + spray of insecticide (spinosad i.e. tracer 24% SC) @ 25ml / liter of water at every 15 days interval after the emergence of pest
T7	Hoeing + bait application (Diptrex+ methyl eugenol + molasses + Vaseline @ 1 : 2 : 2 : 2
T8	Check

The total number of fruits and number of infested fruits were counted and converted into percent infestation by the following formula.

$$\text{Fruits infestation (\%)} = \frac{\text{No. of infested fruits}}{\text{Total number of fruits}} \times 100$$

In the end the economics was calculated by determining yield per trees, along with the cost of treatments. And cost benefit analysis was carried out.

2.1 Statistical Analysis

Data were analyzed according to the procedure appropriate randomize complete block design. The significant means were compared by using least significant difference (LSD) test [13]. Statistix 8.1 package was used for analysis of variance.

3. Results and Discussion

The combination of hoeing under the tree canopy, sanitation practices when used in combination with insecticides (T5) proved the best as shown in Table 2. Almost similar results were obtained from T6 in which similar combination was used except for the spray of spinosad, which was replaced with Diptrex 80% (Table 2). Spray of Diptrex alone (T4) showed moderately effective results. The present results confirm the findings of Haider *et al*., [14] as he reports that spray of Deptrix alone is not very effective. Fruit flies developed resistance against Diptrex in Pakistan as reported by Haider *et al*. [14]. The T7 also failed to reveal better results. Similar results were obtained in the case with T3 and T2 (Table 2).

The T5 and T6 showed the best results with no significant differences in controlling the percentage infestation of fruit fly. However, the spray of spinosad (tracer) alongwith the cultural and sanitation control practices proved to be the best. The results were in accordance with Haider *et al*., [14] found Tracer gave high mortality in field population of fruit flies. These results are also in direct conformity with those reported earlier [15, 16, 17, 18, 19]

Hoeing under tree canopy appeared to be least effective in controlling the infestation. The results were not in conformity with the Liquido [20] as he reports Level of reductions between 75% and 100% are possible if sanitary measures such as the removing of fallen fruit are applied. However this can be applied in the IPM strategy and not alone as The cultural/mechanical control, in the form of field sanitation has been tried as a part of IPM in which the infested fruits are collected and then buried into 4-5 inches deep in soil to destroy maggots which is not possible to bury all the infested fruit on large scale due to labor intensive process, these findings were in accordance with Panhwar [21].

All the results were in accordance with Dhillon [8] that the use of a single control measure such as insecticides can hardly give a total reduction of fruit flies infestation since the damage done by larvae in fruit and vegetables is internal, and therefore difficult to control Dhillon [8]. Based upon the findings of the present study, it can be fairly concluded that the Integrated Management (IM) method of control of fruit fly has a significant effect over other methods on the fruit fly infestation and a visible reduction in the yield losses generally occur due to this major insect pest. [22] There is a need to use insecticides wisely and according to the methods prescribed y the experts and also integrate the insecticides in IPM program [14]

Maximum guava yield was obtained in T5 followed by T6 and T4. Calculation of CBR revealed that T3, T5 and T6 were not significantly different, where as T1, T4, and T7 proved to be not much effective as compared to the other treatments (Table 3).

Table 2: Effect of different IPM strategies on fruit fly infestation on guava orchards

sr. no.	Treatments	Average fruit fly % infestation	
		2013	2014
T1	Hoeing under tree canopy	16.67 b	15.85 b
T2	Hoeing + sanitation	11.45 c	12.67 c
T3	Hoeing + pheromone traps	9.33 d	11.50 cd
T4	Spray of Diptrex 80% WP @ 150 ml/ litre of water	9.15 d	9.87 de
T5	Hoeing + sanitation + spray of spinosad @ 25 ml/ 100 litre of water	6.33 e	6.00 f
T6	Hoeing + sanitation + Diptrex 80% WP @ 150 g/ 100 litre of water	7.33 e	8.17 ef
T7	Hoeing + bait application (Diprex + methyl eugenol + Molasses + Vaseline; 1: 2 : 2: 2)	10.50 cd	11.50 cd
T8	Check	21 a	18.75 a
LSD value at 5% level		1.755	1.555

Table 3: The Effect of Treatments on Yield and their Cost Benefit Ratios

sr. no.	Treatments	YEILD (Kg/ 3 Trees)	Increase over control	Benefit (value)	Expense (PKR/3 trees)	Net benefit	C:B ratio
T1	Hoeing under tree canopy	90	21	525	133.3	391.7	01:02.93
T2	Hoeing + sanitation	135	66	1650	249.9	1400.1	01:05.7
T3	Hoeing + pheromone traps	165	96	2400	151.08	2248.92	01:14.88
T4	Spray of Diptrex 80% WP @ 150 ml/ litre of water	195	126	3150	702	2448	01:03.48
T5	Hoeing + sanitation + spray of spinosad @ 25 ml/ 100 litre of water	270	201	5025	318.97	4706.03	01:14.75
T6	Hoeing + sanitation + Diptrex 80% WP @ 150 g/ 100 litre of water	255	186	4650	293.31	4356.69	01:14.85
T7	Hoeing + bait application (Diprex + methyl eugenol + Molasses + Vaseline; 1: 2 : 2: 2)	150	81	2025	199.42	1825.58	01:09.15
T8	Check	69					

Based on the cost: benefit ratio T3, T5, T6 showed best results, with ratios more or less similar to each other's (Table 3). These findings indicated that hoeing when used with pheromone traps (T3) showed good results in controlling the fruit flies in guava while maintaining the costs. Similarly hoeing and sanitation when sprayed with spinosad as well sprayed with Diptrex showed good results. Hoeing under tree canopy alone showed lowest benefit as compared to cost, thus rendering it unfit economically to be used alone.

4. Conclusion

Based on the finding of the present study it can be concluded the integrated management of fruitfly using cultural methods, sanitation and spray of insecticide has significant effect over other methods on the fruit fly infestation in the guava orchards.

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