

Review Article

A review of the efficacy and management of fruit flies, through different techniques used in fruit orchards of Pakistan

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Abstract

The review-based study was conducted on the enhancing efficacy of fruit fly management techniques in fruit orchards throughout the world and Pakistan. The study aimed to find alternative solutions to the excessive use of different toxic chemicals used in the case of pest management in the agriculture sector in Pakistan. The database shows that there is not sufficient review base data recorded on local bait applications in fruit fly management in Pakistan. The literature from science direct.com, Scopus, and google scholar show that the use of insecticide application as the foliar spray has a residual effect both on crops, vegetables and pets and becomes a source of contamination in a residential area still, instead of using high-cost value artificial lures as fruit fly attractants, Excessive use of chemical, urea, and local baits applications have a positive approach an orchard grower. While in case of toxic bait used in trap McPhail trap, bucket trap internationally but in Pakistan flat trap, in case of color selection yellow and white color play a key role in pest management program.

Keywords: Attractant; Bait; Enhancing efficacy; Fruit fly

Introduction

The fruit fly is considered the major pest of fruits and vegetables worldwide. Most of fruits and vegetables are rotten due to fruit flies' extensive damage throughout the world; therefore, scientists constitute fruit flies as an essential group of quarantine pests. During biological studies of fruit flies, researchers observed that the Female fruit fly lays eggs inside the fruits and becomes a significant source of contamination in more than 400 different fruits and vegetables [1]. While In Pakistan Eleven fruit fly species researchers investigated included different *Bactrocera* species i.e *Zonata*, *Cucurbitae*, and

Dorsalis [1-3]. Heavy losses were reported in various fruit orchards located in different parts of the country [4]. However, many researchers suggest chemical control is the best practice in pest management techniques [5-7]. Most growers currently depend upon insecticide application against the fruit flies with some valuable results [8-10]. insecticides, in this case, are not effective because fruit flies lay eggs inside the fruits, and maggots remain protected in the host tissues, therefore the insecticide application is not reached to the targeted position [11].in our country Pakistan, growers have problems of infestation of fruits and vegetables, the present study was

investigated and kept in mind to find out such valuable methods from the literature which are socially acceptable and economically feasible in farmer community.

Database sources

We used Google Scholar, Science Direct, and Scopus to make a database of publications that provided benefits to research scholars used in fruit fly monitoring and pest management program. The search: fruit fly management: keywords in the research index, shows 341,000 results above for study purposes. The literature-based study has described different aspects related to the fruit fly, biology, and different methods used by researchers in the case of fly pest management and control programs. Still, we have selected the most common method that is valued worldwide.

Trapping strategies

The scientist used an effective method of traps commercially in fruit orchards as a management tool against peach fruit flies [12]. Researchers suggested to use McPhail traps in the citrus orchard have better than the Lynfield trap. During March, the use of cue lures baited traps against sterile Queensland fly. The cue lure was highly influential in an Australia's south wale region [13].

The efficiency of three types of popular traps available in the market, McPhail traps, ChamP yellow sticky traps and AM yellow sticky panel was earlier tested for monitoring the olive fruit fly (*Bactrocera oleae* (Gmelin)) in olive orchard. The McPhail traps captured more olive flies than other trap types. The experiment resulted that AM yellow sticky panel was more effective than the Cham P panel [14]. While when the McPhail traps were baited with synthetic lures e.g ammonium acetate and putrescine captured more Mexican fruit flies in the citrus orchard as compared to other two bait Torla yeast and borax slurry. The non-target insect in traps captured comprised ninety % belonging to order Diptera [15]. Comparing three baited traps,

camerara traps, buminal and bion traps tested only for male fly in Egypt, the highest Mediterranean fruit fly catches were counted from buminal traps followed by other traps. At the same time, the highest catch of peach fruit flies was found in cera traps, followed by others [16]. In California, an olive tree orchard, Pherocon AM traps against fruit fly, *Bactrocera oleae* in a commercial fruits orchard was significantly captured more than in ChamP traps. Besides in Pherocon AM traps have more significant numbers of female flies [17].

The literature base study on mass trapping applications against tephritid fruit flies revealed that we proceed to go back to the early 1920s. In 1925, an Australia against fruit fly for the first time utilized baits comprising protein along with fermenting sugar in the trap [18]. In the same era the bait used was made of glass jars containing molasses and wine vinegar in composition [19, 20]. In the mass trapping method researcher used Eco Traps and the pupal parasitoid *Psytalia concolor* Szepliget effective against olive fruit fly, *Bactrocera oleae* [21].

The Shape and colour of the fruit fly traps are practical tools and is best practices in various part of the world. The male of *Bactrocera dorsalis* in maximum numbers in guava orchards recorded in colour buckets traps having white or yellow, followed by the green, red, and black traps. The important factor colour involved in the attractiveness of traps depend upon the Intensity and reflection of light [22]. But in triangular shaped traps, male flies were reported in highest in numbers in guava orchards as compared to cylindrical, spherical and PAU shaped traps [23]. The earlier reported indicates that the synthetic lure either Methyl eugenol (ME) or Cue-lure in bucket traps is the best choice for *Bactrocera dorsalis* (Hendel) and *B. Cucurbitae* (Coquillett). The two lure were efficient for 4 weeks in the orchard [24]. The lures combine with traps against *Bactrocera cucurbitae* show that trap shape

and lure combination (Jar trap + Cue lure + ME) have maximum efficiency in the Melon field [25].

Fruit fly management through bait

The life cycle study of fruit fly revealed that when the maggot emerges inside the fruit and changes to an adult form. Its survival must feed regularly on carbohydrates and water. In contrast, female flies require proteinaceous base food for the development of their sexual organs and survival [26, 27]. When fruits and vegetables in crop season in full swing, fruit flies can be controlled by using a mixture of insecticide and protein base food attractants, commonly known as insecticide bait sprays. In this effective method the fly feeds on poisonous bait and is killed [28, 29]. Worldwide, scientists have used bait applications to control the infestation of fruit fly species *Ceratitis capitata* (Wiedemann) [30]. The literature-based study from different articles resulted various tested material as bait spray, including birds dropping of domestic hen, chicken feces, feral geckos, Myna birds being highly efficient compared to domestic animal's manure [30-33]. The research findings show that birds dropping or chicken feces in fresh farm could increase the efficiency of lures for monitoring or managing fruit fly *Ceratitis capitata* females [31]. An integrated pest management approach researcher used Protein baits spray of apple cider vinegar, wheat bran powder, red wine and fresh enzyme from papaya and pineapple were produced from different sources tested and resulted that brewers spent grain bait were efficient and effective only in fresh farm to female flies only [34]. Worldwide Different types of baits used are shown in (Table 1).

Fruit management through Pheromones

In fruit fly control strategies worldwide. The male inhalation techniques (MAT) method is used against different fruit fly species. In MAT adult males fruit flies are attracted by lure or Para pheromone along with the addition of insecticide or toxic

chemicals, so female fruit flies normal mating is disturbed and left on an unmated farm and The fruit or vegetables may be protected [35]. In a research study it's clear that male lure methyl eugenol captured fruit fly species *Bactrocera philippinensis* in more significant numbers as compared to female flies and non-irradiated males [36]. The Protein bait used in McPhail traps prepared from the acid hydrolysis of yeast from brewery waste is same potential as imported bait [37]. After using cue lure in vegetables orchards have more effective as compared to other lures Methyl eugenol while population of the fruit fly increases with temperature [38]. The lure Methyl Eugenol and protein bait Nu-lure manage *Bactrocera invadens*, *Ceratitis cosyra* and *Ceratitis capitata* in mango, guava fruits orchards. The efficiency of synthetic lures was maximum recorded, but Nu-lure bait have poor fly species choice in the experiment [39]. Different types of systemic insecticide against Mediterranean fruit fly and citrus mealybug *Planococcus Citri* infestation were not effective treatments and recommended 30 trap ha-1 method are sufficient to control of *C. capitata* [40].

Fruit fly Management through insecticides

Worldwide different insecticide groups are applied against fruit fly species to get pest free crops or vegetables in high yield among these Lambda-cyhalothrine, Deltamethrine controlling melon fruit fly in cucumber field [41]. The Excessive use of insecticide produces resistance to the fruit fly, which was earlier determined in a study [42]. The different insecticides resistance was tested in laboratory bioassay as a standardized method with Food and Agriculture Organization (FAO) [43]. Therefore scientists suggested to using bait spray, but in field or orchard the insecticide malathion with bait Nu lure or GF-120 at a meagre rate or spinosad base bait, in high rate during use of spray equipment is cost-effective against Mexican fruit flies infestation in citrus [44].

The application of insecticides spray revealed that the test insecticides lambda-cyhalothrin (0.004%) emamectin benzoate (0.002%) were the most effective insecticides if applied in the cucumber field against *Bactrocera spp* [45]. In south Asia especially in Pakistan various insecticides groups e.g. Chlorpiriphos, Thiodan, DDVP were tested. Researchers found that that Saprofan-SP proved to be the best in results as a toxicant followed by Fyfinon and Decis-D [7].

During the field or fruit orchard application of insecticides group organophosphorus insecticides (Ops simulated concerned (fenthion and malathion) with direct dermal contact or inhalation are highly toxic. The data on toxicological risk assessment on these group to determine ,likely have residual effect and led to contamination of residential area and domestic animals [46]. However, most growers depend upon the insecticide's application [9, 10]. But the insecticides treatment is ineffective because fruit fly eggs and maggots are remain inside the host tissue [11].

Fruit fly management in Pakistan

The fruit fly species, *Bactrocera zonata* (Saunders) (Diptera: Tephritidae) is the most severe and abundant pest reported globally. The infestation of *Bactrocera zonata* is not limited to vegetables group pumpkin, tomato, etc, but eggplant and pepper as a secondary hosts reported in some countries [16, 47].

The fruit fly is a serious pest in Pakistan, recorded losses from 50 to 90% of fruits and vegetables. The common reported species of fruit flies are *Bactrocera zonata*, *Dorsalis*, *Cucurbitae*, *Dacus ciliates* and ber fruit fly *Carpomya vesuviana* in Pakistan. The infestation of these different species in the agriculture sector is a big source of financial losses. It creates health problems and quarantine risks due to the low quality of fruits and vegetables [48]. In Pakistan Khyber Pakhtunkhwa province, The District Swat is located at 34°46'58" N and 72°21'43" E,

bordering Chitral in the north, and Dir in the west, and Gilgit-Baltistan in the northeast. It covers an area of 5337 s.q km and has a population of 1.26 million [49]. In Swat more than 66 species (with a wide range of genetic diversity in each) of fruits, vegetables and cereal crops are cultivated in the area, which can be distributed into nine types of cereals ,vegetables and fruit including oil seed, cereals, pulses or legumes , condiments, fruits, vegetables, Fodder, starch and fibre crops [50].

During 2011-2012 research study conducted to examine the efficacy of pheromone base trap and the population trend of the fruit fly in Swat [51]. During the summer season, the para pheromones trap different design and shape tested such as flat and box- type shape used in peach orchards. The maximum flies catch were counted from flat trap followed by box type trap in this vicinity [52]. Besides fruits fly infestation at district Swat tehsil, Matta as monitored using two lure methyl eugenol, cue-lure, protein bait and protein hydrolysate. The Pheromone traps comprised 2ml lure and protein hydrolysate, with a mixture of sugar and 2gm poison insecticide Linate selected. The maximum mean number of peach fruit fly is reported from two-lures while protein base bait has low in performance. The researchers recommended that the two lures used in MAT Programme against peach fruit fly management [53].

Swat is called Switzerland of Pakistan. It is the centre of fruit and vegetable production in Khyber Pakhtunkhwa (KP) province of the whole country. The Swat highly has importance in producing fruits including Apples, peaches, persimmons, apricots, pears, plums and walnuts and cherry at Kalam.

The area of Swat is also well known for producing different types of vegetables like tomatoes, potatoes and onions [54, 55]. Before the conflict, Swat's One of the agricultural specialty was peaches; It has been reported that the Pakistan national production made up more than 50 percent

from different peach fruit varieties cultivated in Swat [56].

Table 1. List of different baits used in fruit flies' management programme

Composition of bait	Fruit fly species	Author(s)
NuLure and Buminal	<i>Ceratitis capitata</i> Wied	[57]
Human urine and chicken feces	<i>Anastrepha</i> species	[33]
Honey. Nu-lure Mazoferm and Provesta @1.192 g/ml	<i>Ceratitis capitata</i> (Wiedemann); <i>Bactrocera cucurbitae</i> Coquillett; <i>dorsalis</i>	[58]
GF-120.	Tephritid fruit flies	[59]
Fertilizer, Chicken litter	<i>Ceratitis capitata</i>	[30]
Guava juice 25% of natural guava juice + 10 % of granulated sugar Chicken manure 10 %, Horse manure 30% Cattle manure 50% different concentrations Pig manure 70% Sheep manure 100%	<i>Ceratitis capitata</i>	[32]
Torula Yeast Urea, Human Urine	<i>Bactrocera invadens</i> <i>Ceratitis capitata</i> <i>Ceratitis cosyra</i> <i>Ceratitis quinaria</i> <i>Dacus ciliatus</i>	[60]
Essential oils of Angelica, Ginger root, manuka, Orange, Cubeb, and Tea tree	<i>Ceratitis capitata</i>	[61]
Fresh grape juice Grape Juice (7 days) Grape Juice (14 days)	<i>Anastrepha fraterculus</i>	[62]
Green Ocimum (leaf extract) (3ml) + Malathion (2ml) Black Ocimum (leaf extract) (3ml) + Malathion (2ml) Cinnamon (leaf extract) (3ml) + Spinosad (2ml) Molasses (3ml) + Spinosad (2ml)	<i>Bactrocera zonta</i>	[63]
Piper cubeba crude oil (Fam: Piperaceae), paraffin oil 4 vol African ginger bush, <i>Tetradenia riparia</i> (Hochst.)	<i>Bactrocera zonta</i> <i>Ceratitis capitata</i>	[64]
Codd (Lamiaceae) oil from tea tree (Maiden and Betche) Cheel.)	<i>Melaleuca alternifolia</i>	[65]
32-Different Synthetic Food bait including Ammonia in trap	<i>Bactrocera zonta</i>	[66]
Bio dealer, Bio lure	<i>Ceratitis capitata</i>	[67]
Torula yeast, borax solution 2-3 synthetic food cones	<i>Bactrocera dorsalis</i> Melon fly, <i>Zeugodacus cucurbitae</i> ,	[68]
Yeast Hydrolyzate	<i>Bactrocera tryoni</i> (Froggatt)	[69]
Yeasts	<i>Bactrocera oleae</i> Rossi	[70]

Research workers have done a lot of work on a different tactic to manage fruit flies as

a severe pest in the Swat area of Pakistan [71]. The growers prefer and use

hazardous chemicals and high-cost value commercially available fruit fly attractants [71]. However, there is not sufficient data recorded to use local food bait attractants against fruit flies in the Swat district of Pakistan.

Conclusion and Recommendation

From the literature base study, it is concluded that insecticides have a residual effect both on the environment and human health and cause a resurgence outbreak of a secondary pest as a primary pest, it means to disturb the food chain. [72]. The McPhail traps used in fruit fly management programme also attracted the non-target species of order Diptera, mostly pollinators [15]. Further studies are required to find out different species captured in McPhail baited traps. The urea and manure are easily handled, a less expensive well-known product in the farmer community, as a bait is suggested to be tested both at field and laboratory level to improve the grower's life span and decrease the excessive use of insecticides in the environment.

Authors' contributions

Conceived and designed the idea: MW Khan, Performed the experiments: MW Khan & Z Hussain, Analyzed the manuscript: MW Khan, Z Hussain & K Jehangir, Wrote the paper: MW Khan.

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