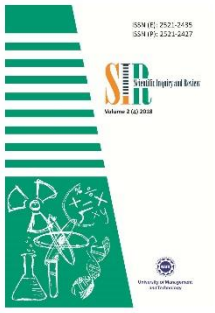

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Author(s): **Sadia Sidra Aziz**
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Fruit Pest Management in Pakistan: A Review

Sadia Sidra Aziz[1*], Mubashar Hussain[2]
[1, 2]Department of Zoology, University of Gujrat, Pakistan

*sadia.sidra.aziz@gmail.com

Abstract

The purpose of this article is to review the several techniques used to control various pest species of fruit crops in Pakistan. Fruit pests cause considerable damage to Pakistan's economy as fruit crops contribute approximately 13% to the GDP of Pakistan. Fruit exports of Pakistan reach up to 2366.5 billion rupees. Unfortunately, a major portion of these crops is lost annually because of pre-harvest or post-harvest pest infestations. Fruit flies, citrus whiteflies, cloudy winged whitefly, citrus blackfly, citrus leafminer, Nile whitefly, pepper whitefly, common walking sticks, gall midge, mealy bugs, moths and aphids are the most important pest species that infest various fruit crops such as mangoes, citrus, grapes, guava, peach, apple, date palm, banana, etc. Fruit flies pose the biggest threat as they infest more than 50 fruit crops. Pest control strategies practiced in the country include physical methods such as traps, baits, bands, as well as botanical controls, that is, using plant extracts to which pests are attracted and then killed or plant-based pest repellents, and chemical controls involving several types of insecticides and pesticides. Recently, integrated pest management techniques have emerged as successful and eco-friendly methods involving all the available measures to cope with a wide range of pest species, such as plant-based insecticides, traps and baits, mechanical and cultural methods, Male Annihilation Technique (MAT), Sterile Insect Techniques (SIT) etc. These techniques have certain limitations, therefore, the need arises to continuously work for the betterment of existing pest management techniques and proposing new and innovative methods to minimize pest infestation and yield losses in fruit crops.

***Keywords*:** fruit crops, pests, integrated pest management, insecticides, MAT, SIT

Introduction

Pakistan has been blessed with fertile land that makes agriculture one of the driving forces of the economy [1]. Being an agricultural country, Pakistan earns a lot through the export of fruits mainly mangoes, banana, citrus, guava, grapes, dates, and apple. Therefore, the production of fruits has a considerable portion in the economy of Pakistan. Currently, fruit

plants are cultivated over a cumulative area of 7, 76,000 hectares, with a total production of 6432.9 thousand tons. During the year 2013-2014, fruit export contributed 2,366.5 billion rupees in the national economy of Pakistan [2]. Unfortunately, due to the unavailability of a proper marketing system, 30-40% of the product turns to waste before even reaching the consumers [3]. About 78% of the total fruit export of the country is comprises dates, mango and citrus only. Pakistan holds sixth position in the production of dates and mangoes and stands at the twentieth position in the production of apple [4].

Fruits	Area/production	1971-80	1981-90	1991-00	2001-10
Citrus	Area	7.12	6.12	1.33	-0.02
	Production	6.93	5.46	1.9	1.26
Mango	Area	0.36	3.76	0.97	6
	Production	0.58	3.43	1.91	6.43
Date	Area	2.25	5.62	6.24	1.43
	Production	2.34	3.77	7.28	-1.41
Apple	Area	9.9	6.99	8.53	6.73
	Production	11.5	8.02	4.5	-1.79

Figure 1. Average decade-wise production of some important fruits in Pakistan [5]

Pests are the organisms that cause several diseases in plants by using them as food which results in decreased yield [6]. Arthropods are responsible for an annual 18-26% loss of fruit crops worth approximately 470 billion USD worldwide [7]. Annually, over 200 million USD worth of fruit crops are lost in Pakistan because of fruit flies only [8].

For the effective management and eradication of fruit pests, continuous and accurate assessment of their population size, including both larvae and adult population is of utmost importance [9]. The development of new pest management strategies with maximum efficiency and minimum hazards is the utmost requirement for an increased yield of fruit crops. The current article reviews various pest management strategies employed for the efficient management of the pest species.

3. Most Important Fruit Pests in Pakistan

Procontarinia mangiferae (Diptera: Cecidomyiidae) are widely distributed worldwide and are notorious for mango infestation [10]. Out of the many important fruit pests, fruit fly (*Bactrocera zonata;* Diptera: Tephritidae) is considered as the most important economically as it affects about 50 fruit species, such as peach, custard apple, mango, date

palm, citrus, banana, permission, batsch etc., although it prefers guava mostly [11, 12]. Citrus whiteflies (*Dialeurodes citri*), cloudywinged whiteflies (*Aleurotuberculatus citrifolii*), citrus blackfly (*Aleurocanthus husaini*), citrus leafminer (*Phyllocnistis citrella),* Nile whitefly (*Aleurolobus niloticus*), *Aleurocanthus woglumi, A. jasmine, Amurrayae,* Pepper whiteflies (*Aleurotrachelus spp*.) and common walkingsticks (*D. elongate*) are involved in the infestation of citrus fruits [13]. *Diaphorina citri* (Homoptera) is found widely in areas where citrus is grown [14]. Mealy bugs and fruit flies are recognized as important pests of mangoes [15]. Aphid are known for their infestation of peach [16].

4. Pest Management Techniques

In Pakistan, many pest management techniques are in practice depending upon the nature and kind of fruit crop and pest species. Some are described below.

4.2. Botanical Control

Several plants provide us with a variety of extracts that are effective against many species of pests [17]. Leaf extracts from plants including *Thevetia peruviana, Cassia fistula, Azadirachta indica, Ocimum basilicum, Datura alba* and *Eucalyptus camaldulensis* provide repellency up to 84% and decreased pupal growth [18]. Extracts of plants from Pakistan's northern areas, such as *Eucalyptus sideroxylon, Isodon rugosus, Cinnamomum camphora, Calotropis procera, Boenninghausenia albiflora, Tagetes minuta* and *Daphne mucronate* provide repellence, deterrent oviposition and high mortality in adult specimens of various pest species [19]. Turmeric extract solution in a range of organic solvents such as ether, ethanol, acetone etc. cause growth inhibition and repellence in *B. zonata* [20, 21]. Many insects are attracted towards some organic compounds such as methyl eugenol and few phenylpropanoid compounds found naturally in various species of plants [22]. Extracts derived from species such as *Azadirachta indica, Peganum harmala, Acorus calamus, Curcuma longa, Valeriana jatamansi* Jones and *Saussurea lappa* have proven to be effective against a wide variety of insects [4].

Essential oils derived from plants have some compounds such as phenols, terpenes, etc. that are reputed to be efficient insect repellents [16]. Extracts of *A. indica* elicit repellence and antifeeding effects in oriental fruit fly species [23]. Bio pesticide derived from neem tree shows effective repellence against *D. citri* spp. [24]. Organic solutions

of turmeric extracts contain turmerons such as alpha and beta termerons that are highly effective in terms of repellency and mortality rate [25]. Methyl eugenol is used for monitoring and suppression of pest populations [26].

4.3. Chemical Control

Chemical control methods are the most common measure for pest management in Pakistan [27]. The use of pesticides began in 1952 in the country [28] and reached up to 25 thousand metric tons in 2006. Most commonly used pesticides belong to pyrethroids, organophosphates and organochlorine such as fenvalerate, mevinphos dimethoate, fenitrothion, endosulfan, deltamethrin, chlorpyriphos, methyl parathion dicofol, cypermethrin, profenofos and dichlorvos [29]. Diazinon, Endrin, Dimecron, Diptrex, and Dialordin as well as pyrethorids organophosphates and carbamates are effectively used against mango, peach, melons, banana, guava, apricot, plum, persimmon etc. [30]. For the infestation of fruit flies, Metasystox, Dipterex, Folidol, Nogos and Dimecron are generally employed [31].

However, synthetic insecticides are less preferred now because of the adversaries associated with them such as the issues related to international trade, poisonous residues that insecticides leave inside fruits and environmental damage [32]. Also, their increased usage is associated with insecticide resistance. For example, specimens of *B. zonata* are increasingly resistant to commonly used insecticides such as malathion, lambda-cyhalothrin, trichlorfon, bifenthrin, spinosad and methomyl etc. [33].

4.4. Integrated Pest Management

Insect Pest Management (IPM) refers to a collaborative approach involving all the available and possible measures to reduce the population of various insect in order to avoid the use of harmful insecticides. IPM techniques have been devised to suppress the increasing use of insecticides because of hazards associated with them. IPM techniques are effective, environmental friendly and reduce infestations [34]. IPM techniques have been effective in controlling fruit fly infestation up to 17% in guava orchids [35].

Burying after burning treatment, burlap and sticky bands, ethyl eugenol traps and stem injection have proven to be highly effective against fruit flies and mealy bugs infestation in mangoes [15]. Techniques such as Male Annihilation Technique (MAT), cultural

control and Bait Application Technique (BAT) have proven to be effective against oriental fruit fly [36].

Infestation of mango fruit by gall midgets is dealt by using sticky traps of various colors and by applying the extract of seed kernel derived from neem tree [10]. The mechanical/cultural technique of IPM involves sanitation of the fields. In this process, fruits infested with maggots are collected and then buried at the depth of 4-6 inches in the soil for the destruction of maggots [37].

A newly introduced technique called Sterile Insects Technique (SIT) has many benefits such as it is eco-friendly, can be used over many pests, reduces growth rate of insects by producing large numbers of sterile males using radiations that introduce reproductive failure in their mates [38]. Gamma radiations alter the anatomy, morphology and development of gonads in fruit flies. These radiations cause decreased egg hatching and adult emergence, decreased size and sex ratio and total sterility of eggs [39].

However, IPM techniques have certain limitations too. For example, the mechanical/cultural technique is not suitable because of cost ineffectiveness as it is not possible to bury all the infested fruit because of high labor costs [37]. The use of predators and parasites have proven inefficient because of the higher fecundity of fruit flies than parasitoids and the poor searching abilities of the latter for pupal and larval populations of the target species [40].

5. Conclusion

For obtaining maximum yields from fruit crops, efficient management of pest species is of utmost importance. Therefore, there is a perpetual need for advancements in pest management strategies because of increasing pesticide resistance. Integrated pest management strategies are at an increased advantage over the use of conventional insecticides because of effective reduction in population size and pest repellency, environmental friendliness, lack of residual compounds in fruits etc.

For pest management strategies to become successful, area-wise population assessment of prevailing insects is mandatory. It is beneficial to study the habitats preferences, feeding habits and behavior patterns of pests to devise efficient control strategies. Investigations are necessary for the separation and identification of active compounds in plant extracts, insecticides, and pesticides in order to use these compounds efficiently. Techniques should be developed to control increasing pesticide resistance in insects, together with the prevention of

indiscriminate pesticide usage. It should be ensured that consumers are not eating fruits containing pesticide residues. For this purpose, innovative methods such as gene manipulation to reduce the reproductive capabilities of the pest species are required to overcome the limitations of IPM techniques.

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