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Original Research Article

A SURVEY REGARDING MANGO FRUIT BORER INFESTATION IN MANGO ORCHARDS OF PUNJAB PAKISTAN

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Abstract: *Mango is an important tropical fruit crop grown in most parts of the world including India, Pakistan, China, Bangladesh, Burma, Thailand, Japan, New Zealand, Australia, Indonesia, Africa, Brazil, Mexico and some US states. Mangan o is an important fruit crop for Pakistan due to its delicious taste, rich in vitamins A and C-and high-income returns to mango growers. However, in recent years a new pest problem mango fruit borer extensively damaged mango fruit crop in all mango growing districts of Punjab and Sindh. This insect was previously not even recognized as an important pest of mangoes in Pakistan among farmers and the scientific community, however since 2017, very serious complaints have been received from mango orchard owners regarding damage caused by MFB in the fruit clusters. Hence a survey was conducted in four districts of Punjab Pakistan viz., Multan, Muzaffargarh, Khanewal, and Rahim Yar Khan. About 145 mango growers were randomly chosen for interviews to learn about farmer perceptions and management of mango fruit borer. A series of open-ended and closed-ended questions were asked. Data was analyzed through the Chi-square test using Statistix 8.1 software. Farmers were asked various questions regarding farmers' identification of MFB stages and the nature of the damage, varietal preference of MFB, resting or hibernating places of the pest, insecticides used to control the pest, weeds as the reservoir of the pest and many more. Overall, most of the farmers were primarily qualified, males and had orchard sizes of 2 to 10 acres. Farmers reported that Sindhri was mostly affected by variety. Farmers used insecticides to control the pest menace and achieved around 40-80 % control. The knowledge about species recognition was very low among farmers. Based on this survey, we recommend farmer training programs regarding pest management, enhancing awareness among farmers regarding pest attacks, pest scouting, pest recognition and incorporation of cultural control techniques along with insecticides as a necessary part of pest management should be explained.*

Keywords: Mango Fruit Borer, Survey, Open Ended Questions, Integrated Pest Management, Biological Control, Farmer Awareness

Introduction

Mango (Mangiferae India) (Ancardiaceae; Sapindales) is an important tropical fruit crop in Southeast Asia. (1). Due to its delicious taste, vitamin A & C combinations, and this fruit is extremely liked all over the world. (2-5). Vitamins and minerals rich this yellow fruit is regarded as the king of fruits.(6). The mango is grown in several communities including India, China, Bangladesh, Indonesia, Thailand, Mexico, and Brazil, and even some part of it is grown in the USA states of Florida and Colorado. (7-11). Pakistan is 4th largest producer of mangoes (26.3 million tons) after India (26.3 million tons), Indonesia (4.1 million tons), and China (3.8 million tons) (SARMeco International exporter). In 2020, Pakistan exported over 125,000 tons of mangoes worth 72 million US dollars (SARMECO). In 2023, Pakistan exported 129,000 metric tons of mangoes. (12). Pakistan can increase its export of mangoes through the adoption of various packaging and post-harvest care practices.

Among the countries where the mango is exported, Iran is the largest importer, followed by UAE. Pakistani mango export is very low in Europe and the United States due to longer distances short shelf life and post-harvest losses caused by poor handling of fruits in orchards and pest-induced losses. An array of insect pests attack on mango crop, among which mango fruit borer *(Citripestis eutraphera)*(Lepidoptera: Pyramidal) though classified as a minor pest until 2017 has now emerged as a potential destructive pest in mango growing districts of Punjab Pakistan. Mango fruit borer though classified as a minor pest of mangoes until 2017, however, in 2020 very serious losses to mango fruits occurred. Different species complex of mango fruit and seed borer viz., Cogonathus punctiferalis (Guenee), Autocharis (=Noorda) albizonalis Hampson (Lepidoptera Pyralidae); Citripestis eutraphera (Lepidoptera: Pyralidae) and Deanolis albizonalis (Hampson) (Lepidoptera: Pyralidae) have been known to damage mango quantitative production. (13-18).

Mango fruit borer problem has been reported in India (14, 19), Bangladesh (20) and Pakistan (21). In Pakistan, the mango fruit borer complex was not a major pest of mangoes until 2017. Farmers even don't recognize it as a threat to the

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mango industry in Pakistan. Farmer's perceptions often lead scientists towards developing management techniques against target pests. Based upon farmer complaints about the attack of fruit borer complex on mangoes a survey questionnaire was designed to develop an integrated pest management strategy against mango fruit borer. The present study was conducted to determine whether farmers recognize mango fruit borer as an important pest and threat to the mango industry. To determine the farmer's perception about the susceptible varieties of mangoes.To assess farmer practices for management of the mango fruit borer and the damages caused by it in different varieties of mangoes.To develop a management technique based on the survey results.

Methodology

This survey was conducted in southern Punjab Pakistan. Pakistan is blessed with variable climates from continental type in the north (Gilgit, Baltistan, Kashmir and KPK), a mountainous dry climate in Balochistan, a wet climate in east Punjab and an arid climate in southern Punjab Pakistan (Fig 1). Five rivers irrigate the Punjab province. The fertile land of Punjab is famous for the production of mangoes, citrus, dates, guava and many delicious fruits. Among these mango ranks second most important fruit crop in Pakistan and brings higher foreign exchange through export.

Due to the agro-climatic conditions of the Punjab and Sindh provinces of Pakistan, the mango fruit crop is widely grown in the southern Punjab Pakistan and Sindh province districts of Badin, Sakkhar, and Hyderabad. The Punjab province districts Rahim Yar Khan, Multan, Bahawalpur, Khanewal and Vehari are hubs of mango production in Punjab. Hence, the study was conducted in the four districts viz. Multan, Muzaffargarh, Khanewal, and Rahim Yar Khan due to extensive cultivation of mangoes in these districts of Punjab Pakistan.

Questionnaire design and farmer survey methods

A survey performa of mango grower's perceptions regarding mango fruit borer infestation was designed to evaluate the farmer's knowledge and perception regarding the management of mango fruit borer in these different of Punjab Pakistan (Table 1).

About 145 mango growers were selected for the survey. There were 30 growers from Multan district, 42 growers from Rahim Yar Khan, 20 growers from Khanewal and 53 from Muzaffargarh district. Farmers were visited with the prescribed Performa to collect the requisite information. The survey was conducted from July to August 2020. The interview was conducted either in the orchard or in-house. Each interview took 30 to 35 minutes. Sampling was stratified within each tehsil and each district orchard under production. The questionnaire aimed to assess the aspects to get a clear picture of pest management.

Farmers' knowledge regarding pest management, natural enemies and pest management received special emphasis. The content of the questionnaire and the type of questions asked were agreed upon after key informant interviews. To evaluate farmer's knowledge, perception, and management they were first asked whether they could recognize the pest or not. Questions were asked the about grower's name, age, education, the average age of mango plants in their orchard, name of varieties, orchard area, per cent orchard area affected by MFB, types of insecticide used by farmers, dose of insecticide per 100 ml of water and MFB control percentage achieved through the use of insecticides and a policy question was asked how farmers can improve the poor quality of mangoes.

The data was statistically analyzed through the Chi-square test (Statistics IBM). A map of the world showing Pakistan and different districts of Punjab Pakistan. The surveyed districts Multan, Muzaffar Garh, Khanewal and Rahim Yar Khan are mentioned here.

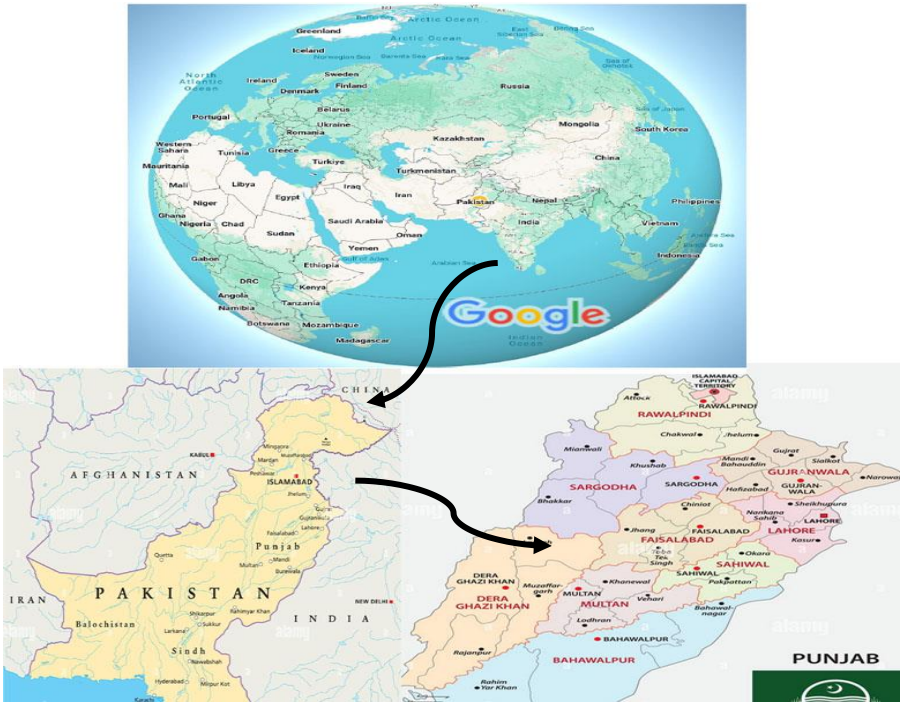

Figure 1:

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Results & Discussion

Distribution of mango growers in four districts of Punjab Pakistan during survey:

This study was conducted in four districts of Punjab to know farmer's knowledge perception and management of mango fruit borer. About 156 farmers were selected from Muzaffar Garh, 43 from Multan, 67 from Khanewal, and 42 from RY Khan. A total of 308 farmers were interviewed (Fig 1). This constituted 50% farmers from Muzaffargarh, 14 % farmers from Multan district, 21 % from district Khanewal, and 13 % from district Rahim Yar Khan. The maximum number of farmers were selected from district Muzaffar Garh (156) and the minimum number of farmers were selected from district Rahim Yar Khan (42) (Fig 1)

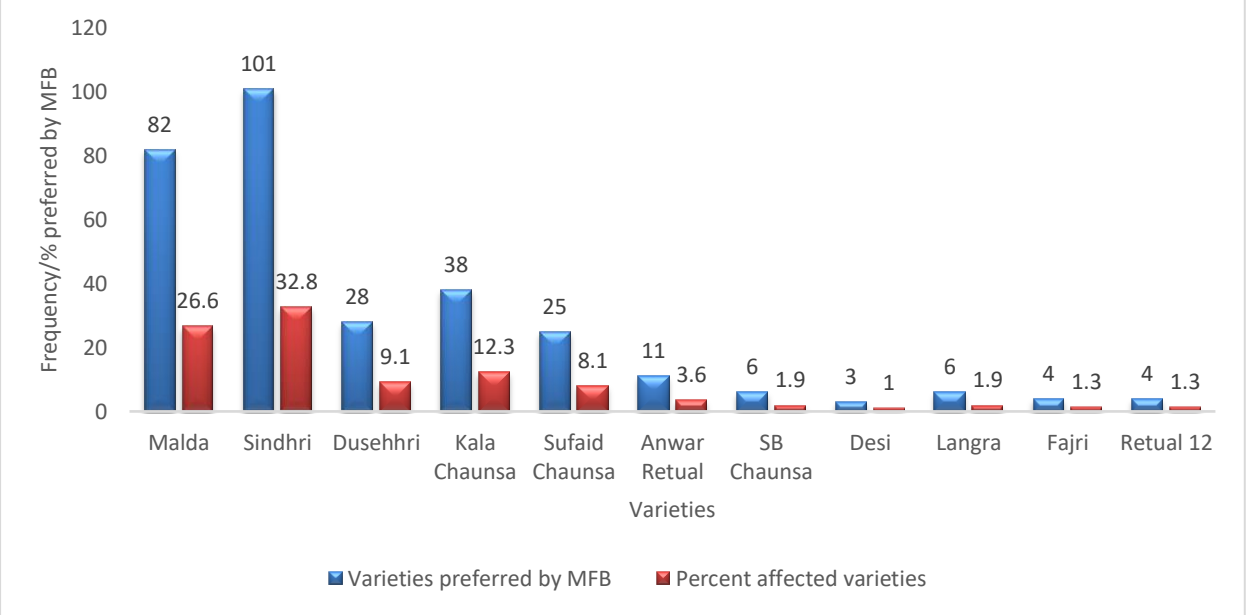

Figure 2:Distribution of mango growers in four districts of Punjab-Pakistan during the survey

Farmer identification of mango fruit borer

Farmers were not able to recognize the adult and pupae stages of mango fruit borer, however, 70% of farmers were able to identify the larvae of the mango fruit borer, 20% of farmers even did not identify the borer larvae, however, they said the dark moistened spot present in between the adjacent fruit is the problem of MFB infestation, while 10% don't recognize MFB or the pest damage identification. Instead, the pesticide company representative told them that the pest was attacking the crop, hence they sprayed larvicides.

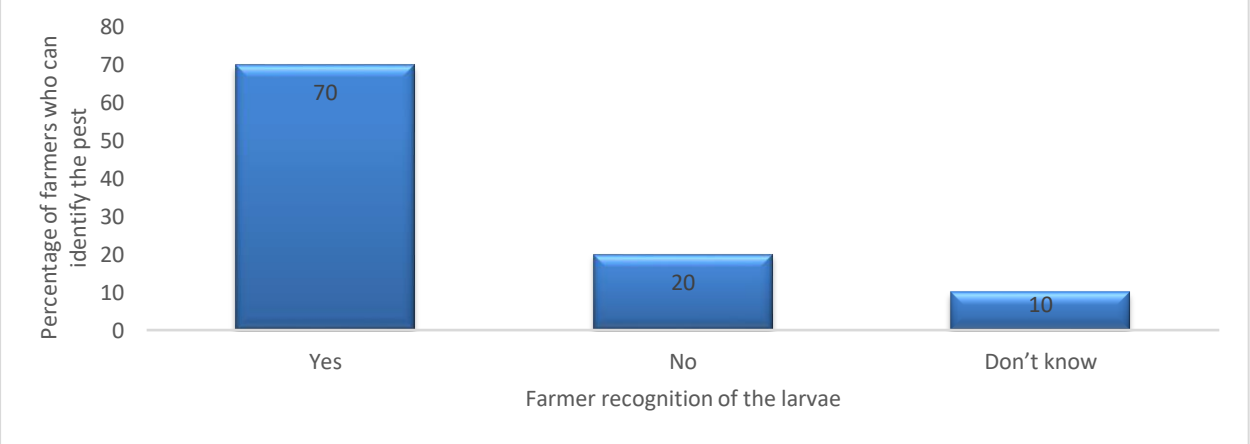

Figure 3: Farmer's knowledge about the identification of different stages of the pest

Response to the question of which variety in your orchard is mostly affected by Mango fruit borer infestation.

When the question was asked, which variety do you deem most susceptible to mango fruit borer infestation, 101 farmers reported Sindhri most susceptible variety, followed

by Malda (82 farmers), Kala chainsaw (38 farmers), Duserhri.

(11 farmers), SB Chaunsa (06 farmers), Langra (06 Farmers), Fajri (4 farmers), Retaul 12 (4 farmers) and Desi (3 farmers) (Fig 2).

About 32.8 per cent farmers reported Sindhri the most susceptible variety followed by Malda (26.6%), Kala Chaunsa (12.3%), Dusehri (9.1%), Sufaid Chuansa (8.1%), Anwar Retail (3.6%), SB chance (1.9%), Langra, (1.9%), Fajri and Retaul 12 (each 1.3%) and Desi (1%) (Fig 2).

Most affected variety of mangoes by *Citripestis eutraphera* (mango fruit borer) in four districts of Punjab-Pakistan during the survey

Response to the question which insecticide farmers use to control mango fruit borer infestation:

An open-ended question was asked to know which insecticide farmers use to control the pest infestation. 140 farmers reported they use abamectin benzoate to control mango fruit borer infestation, 30 farmers reported they use Bifenthrin (Talstar 10EC), 25 farmers reported they used Coragen to control MFB infestation, 21 farmers reported they used lambdacyhalothrin to control MFB infestation, 18 reported they use lufenuron (Match 050 EC), 14 reported they use flubendiamide (Belt 480 SC), 11 reported they use generic insecticide Lufenuron, 9 farmers reported they used chlorantraniliprole, Voliam Flexy, Tricholoroform was used by 3 farmers each to control MFB infestation while Clemizo was used by only one farmer. Overall 29 farmers said they don't use any insecticide (Fig 3).

Overall 45.5% of farmers used abamectin benzoate, 9.7% of farmers used bifenthrin, 8.1 % of farmers used collagen, 6.8% of farmers used lambda-cyhalothrin, while below 5% of farmers reported they used lufenuron, voliam flexy, Tricholoroform and clemizo (Fig 3).

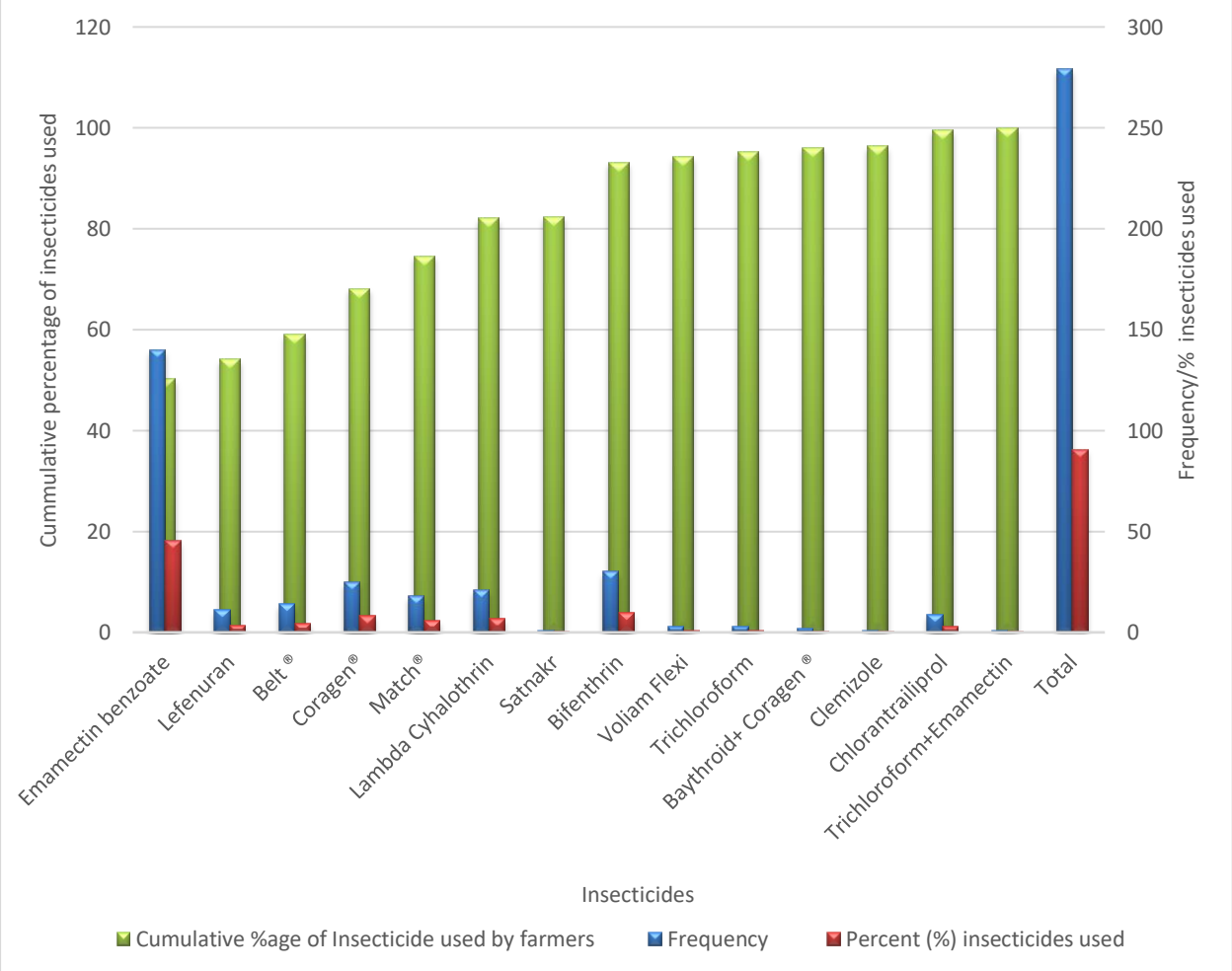

Figure 4: Insecticides most commonly used by farmers against Citripestis eutraphera in four districts of Punjab Pakistan during the survey

***** Missing values row shows that most farmers did not use any insecticide against Citripestis eutraphera on 9.4 % of verities (29/308).

Response to the question of what per cent of control they achieved after insecticide application:

Through insecticide application only one farmer reported 1-10 % control, 37 farmers reported 11-20% control, 39 farmers reported 21-30 % control, 48 farmers reported 31-40% control through insecticide application, while 19 farmers reported 51-60% control, 16 farmers reported 61-

70% control, 57 farmers reported 71-80% control, 81-90 % control was achieved by 19 farmers and only one farmer got 91-100% control in MFB infestation through insecticides application (table 1)

0.4% of farmers achieved 1-10% control in MFB infestation, 12 % control was achieved by 11-20 % of the population while 18.5% of farmers achieved 71-80% control (table 1).

Table 1: Control percentage ranges in reduction of Citripestis eutraphera by chemical management

Control % by chemical management	Frequency of Control	Percentage Control %	Valid Percent	Cumulative Percentage Control
1-10%	1	0.3	0.4	0.4
11-20%	37	12.0	13.3	13.6
21-30%	39	12.7	14.0	27.6
31-40%	48	15.6	17.2	44.8
41-50%	42	13.6	15.1	59.9
51-60%	19	6.2	6.8	66.7
61-70%	16	5.2	5.7	72.4
71-80%	57	18.5	20.4	92.8
81-90%	19	6.2	6.8	99.6
91-100%	1	0.3	0.4	100.0
Total	279	90.6	100.0	
Missing values*	29	9.4		
Total	308	100.0		

* Missing values row shows that most of the farmers did not use any insecticide against citripestis eutraphera on 9.4 % of verities (29/308).

Farmer response to the question that mango malformation is the reservoir of mango fruit borer

In response to this question, the mango fruit borer adult lays eggs in the malformed inflorescence. Larvae initially feed in the malformed inflorescence and then pupate. The next generation of adults lay eggs in between the adjacent hanging fruits at the marble stage, from where the larvae develop and feed on the fruit skin damaging its fruit quality and sometimes the infested fruits fall. Only 20% of farmers said they think the malformed inflorescence is the reservoir of MFB, while 70% said 'no' we don't think that this Mango malformed inflorescence is the reservoir of MFB, while 10% said we don't know, either the pest complete one generation in the malformed inflorescence and adult lay eggs in between the hanging fruit or not.

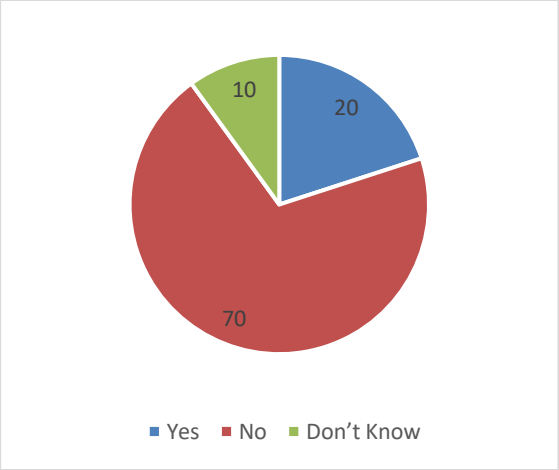

Figure 5: Percent farmer response to the question that malformed inflorescence is the reservoir of the mango fruit borer.

Farmer response to the management of mango malformation

When the question was asked how many times you manage the mango malformation to get rid of the mango fruit borer infestation. About 20% of farmers removed the mango malformation once in the mango fruit development period, while 70% of farmers removed the malformation twice in the fruit development period, while 10% of farmers did not remove the malformation. **Farmer response to the management of mango malformation**

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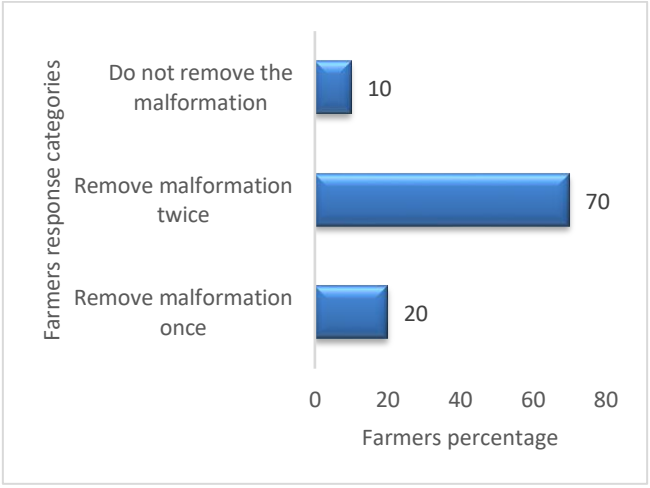

Figure 6: Response of the farmers about malformed inflorescence being the reservoir of mango fruit borer or not can weeds be the reservoir of mango fruit borer.

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When the question was asked, does mango fruit borer spend some time in weeds within the orchard? 10% of farmers responded yes weeds are the reservoir of the mango fruit borer, 70% said no we have never seen mango fruit borer larvae on weeds while 10% said they never investigated.

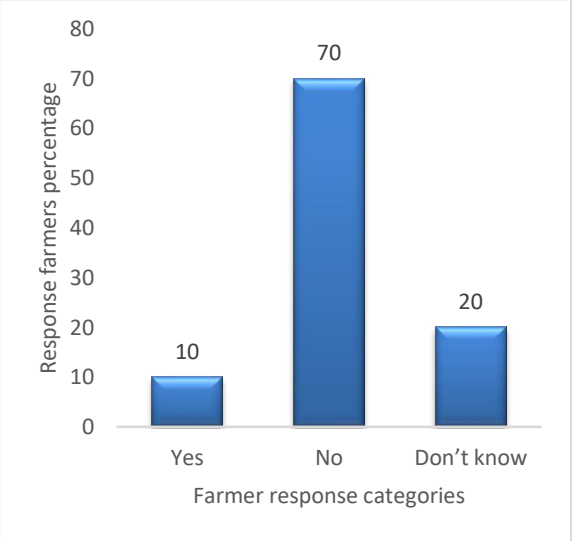

Figure 8: Farmer response to the question of weeds can be the reservoir of the mango fruit borer.

Can farmers recognize the peak period time of infestation of mango fruit borer?

When the population of mango fruit borer reach a peak in their orchards during calendar months. 10% of farmers reported 10% damage in April, 60% of farmers reported in May, and 30% of farmers reported maximum damage in June.

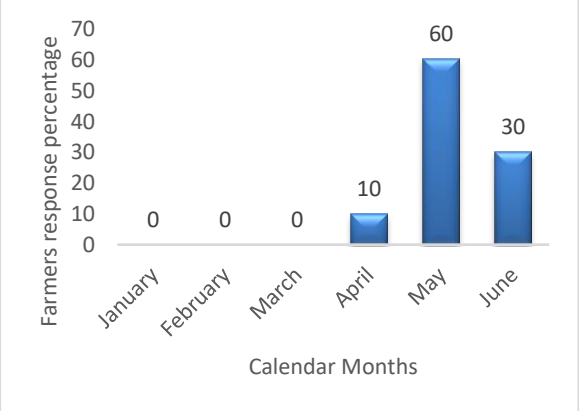

Figure 9: Can farmers respond to the period of maximum activity of the pest

Discussion

The survey was conducted in four districts of Punjab-Pakistan to know farmers' knowledge perception and management of mango fruit borer. About fifty (22) Percent of farmers were selected from Muzaffargarh, 14 % of farmers were selected from Multan district, 21 % were selected from district Khanewal, and 13 % were selected from district Rahim Yar Khan. The maximum farmers were selected from district Muzaffargarh and the minimum farmers were selected from district Rahim Yar Khan. The most susceptible variety of mangoes according to respondents was Sindhri followed by Malda, Kala Chaunsa, Dusehari Sufaid Chaunsa, Anwar Retaul, SB Chaunsa, Langra, Fajri and Retual 12. The least affected variety was Desi with the least frequency (1%).

Overall 45.5% of farmers used abamectin benzoate, 9.7% of farmers used bifenthrin, 8.1 % of farmers used collagen, 6.8% of farmers used lambda-cyhalothrin, while below 5% of farmers reported they used lufenuron, voliam flexy, Tricholoroform and clamato. Overall, 0.4% of farmers achieved 1-10% control in MFB infestation, 12 % control was achieved by 11-20 % of the population while 18.5% of farmers achieved 71-80% control. The farmers mostly used insecticides to control the fruit borer complex.

The agricultural community accounts for 64% of the Pakistani population. (23). Illiteracy among the farmers may lead to poor knowledge of pest management. This poor knowledge decreases the farmer's income and overall export worth of Pakistani agricultural commodities in Pakistan. (24). It is extremely important to train farmers regarding pest management. (24), enhance the knowledge about the hazards of insecticide overuse and biological control. The increased knowledge of farmers may lead to their adoption of IPM programs.(24).

In the current survey, when farmers were asked to identify the adults of MFB none were able to do that, however, larvae were identified by the farmer as the invading pest. Hence, extension survey programs must be initiated among farmers to inform them about pest identification. In the present survey, no farmer relied on the removal of fallen fruits to reduce the infestation of mango fruit borer. The mango fruit borer adult lays eggs in the adjacent hanging fruits, due to which the fruits fall and these immature fruits are often used by the orchard owner to make the Amchur, Khatai and other valuable commodities, hence the quarantine pest MFB spread to new areas as well (19). About 10-52% of fruit loss may occur due to this pest (19). Islam, Kabir (14) determined that mango fruit borer damage can be reduced through bagging mango fruits, however, in Pakistan the mango fruit borer attack is severe in April and May at that time the fruit is immature. Bagging immature fruits in the Sindhri variety at the marble stage may be effective but it should be practised on an experimental basis in the orchards of south Punjab to see the practice effect on the export quality of mango fruits.

Recently a survey paper on mango fruit borer has been published, however, very little information regarding the farmer perception was described. Hence this paper outlines the important information about the perception and knowledge of mango fruit borer management obtained from different districts of Punjab Pakistan.

Conclusion

Mango fruit borer is an important threat to the mango industry in South East Asia. A mango fruit borer pest management strategy should be established in Pakistan to decrease the losses caused by the pest. Moreover, farmers in Pakistan rely on the use of insecticides to control the pest incidence. The mango is a delicious fruit crop in Pakistan. Overuse of the pesticide may leave residues inside the

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mango fruits. Mango is freshly eaten, hence these residues may be harmful to children's health. Hence eco-friendly pest management approaches must be adopted to decrease the pest incidence and reduce the over-reliance on pesticides. Farmers should be trained by researchers, extension agents, and trained scholars of agri universities to decrease their reliance on insecticides. Farmers should be motivated to use bio-control agents, cultural control techniques and physical barriers to reduce the losses caused by pests.

Pakistan is an agro-based country, heavy reliance on the use of pesticides may lead to the resurgence, of minor pests and this would be harmful to the ecosystem. Hence a farmer-friendly, cheap cost cost-effective pest management strategy should be developed.

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Declarations

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All data generated or analyzed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department concerned.
Consent for publication
Approved
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Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

TASMIA LARAIB
Coordination of collaborative efforts.
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Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.
Conception of Study, Final approval of manuscript.
ABID HAMEED KHAN, AMNA AMIR KHAN
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Coordination of collaborative efforts.
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Data acquisition, and analysis.
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Data entry and Data analysis, drafting article.
RIAZ HUSSAIN
Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.
Conception of Study, Final approval of manuscript.
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Manuscript drafting.
TALHA ALI CHOHAN
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Conception of Study, Final approval of manuscript.

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