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FARMERS' PERCEPTION SURVEY AND EVALUATION OF MANAGEMENT PRACTICES FOR MANGO FRUIT BORER (*CITRIPESTIS EUTRAPHERA*)

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ABSTRACT

Mango fruit borer (MFB) is a significant pest that damages mango fruits and leaves. This study explores farmers' perceptions of the mango fruit borer and evaluates management practices. Survey findings indicated that 48% of mango growers believed MFB attacks occur during April-May, while 30% identified May-June as the peak season. Additionally, 84% of mango growers believed MFB affects fruits, while only 2% think it also targeted leaves. Most mango growers (78%) preferred chemical methods to manage MFB, with 40% using bifenthrin, 28% using emamectin benzoate, and only 8% applying imidacloprid. Experiments evaluating MFB's preference for different mango varieties revealed that nearly all commercial varieties had varying infestation levels. Sindhri was the most infested (29.9%), while Doseri was the least infested (12.6%). Light trap data suggested that the maximum moth population occurred during the last week of April. Evaluations of chemical pesticides showed that bifenthrin (250 ml / 100 L of water) was the most effective, while Thiamethoxam + Chlorantraniliprole (80 ml / 100 L of water) was the least effective for MFB. Emamectin benzoate, Chlorantraniliprole, and Lufenuron were better options than synthetic pyrethroids (Bifenthrin) because they were safer for natural enemies and pollinators. Integrated management strategies, such as installing one light trap per hectare and monitoring MFB on mango leaves and weeds in March/April for early detection, were recommended. Additionally, collecting fallen infested fruits and judicious use of insecticides can help mitigate losses caused by MFB.

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INTRODUCTION

Mango (*Mangifera indica*) is considered the king of fruits and is cultivated in tropical and subtropical areas worldwide (Qaiser, 2018; Kumari et al., 2020). It ranks as the fourth major fruit crop among all countries globally (Litz, 2009). The total fruit production was 6796.82 thousand tons in 2018-19, with mango contributing 1723 thousand tons (Anonymous, 2020). Mango exports are increasing due to the involvement of Pakistani stakeholders and the administration's efforts to expand mango exports from Pakistan to international markets (PHDEB, 2005).

Several factors contribute to low yields, including traditional marketing practices, insect pest attacks, lack

of international market standards, and poor pre and post-harvest techniques still prevalent in Pakistan (Ghafoor et al., 2013; Nasir et al., 2014; Shahbaz et al., 2023). The mango fruit borer has emerged as a major pest, reported in Australia and India, causing significant damage during the fruiting stage and resulting in substantial losses to the mango industry (Jayanthi et al., 2014). Among these borers, the red banded caterpillar was first reported in India in 1955 (Sengupta and Behura, 1955). Another notable pest, the pyramids fruit borer (*Citripestis eutraphera*), has been wreaking havoc in mango orchards in Multan for the past few years, leading to yield losses (Qaiser, 2018). Losses of about 25% due to mango fruit damage have been reported from Multan (Qaiser, 2018), with instances of more than one larva of the mango fruit borer found in a single fruit (Golez, 1991; Pinese, 2005; Anderson and Tran-Nguyen, 2012; Qaiser, 2018).

Mango growers use insecticides to control the population of insect pests affecting mangoes. However, excessive use of insecticides leads to increased costs, contamination, and a reduction in biological control agents (Peng and Christian, 2006). Therefore, it is recommended to employ a combination of strategies for insect pest management, including cultural and chemical control methods. Varietal preference likely plays a significant role in borer damage, as fruits with thick skins are less damaged compared to those with thin or soft skins. The Sindhri cultivar is preferred by mango fruit borers over other varieties due to its soft skin, which facilitates easier entry for the borers (Qaiser, 2018). Light traps are effective tools for monitoring insect pests, especially those with nocturnal habits (Jonason et al., 2014). In Pakistan, the most common method used for insect pest control is chemical intervention. However, farmers often report insufficient control with this method.

Given the importance of this pest, the present study was designed with the objectives to 1) conduct a farmer's perception survey regarding mango fruit borer in three mango-growing districts in Punjab, 2) implement cultural management strategies for mango fruit borers, including (a: evaluating varietal preferences of mango fruit borers, b: identifying alternate hosts of mango fruit borers in selected areas and c: monitoring mango fruit borer moths through light traps), 3) conduct toxicological studies on different insecticides for borer management and 4) collect and evaluate potential predators and parasitoids of the borer.

MATERIALS AND METHODS

Survey of mango growers in three districts on different aspects of mango fruit borer

Study areas

Cities in South Punjab, such as Multan, Khanewal, and Muzaffargarh, are renowned for their mango orchards. The survey was conducted during the 2019-20 period. Multan is situated at an altitude of 122 meters, with a latitude of 30.1144 and a longitude of 71.2831. Muzaffargarh, on the other hand, lies at an altitude of 122 meters, with a latitude of 30.0743 and a longitude of 71.184654. Similarly, Khanewal is located at an altitude of 128 meters, with a latitude of 30.2864 and a longitude of 71.9320.

Questionnaire form

Nearly 30 questions were posed to each farmer. These questions covered basic information about mango growers, their ability to identify insect pests, the modes of damage, varietal preferences, cultural practices, chemicals applied, and other management practices.

Survey method

A perception survey of mango growers was conducted by randomly selecting twenty farmers from each district. The survey employed a descriptive method, with twenty growers chosen randomly from a list of 50 growers in each district. Each farmer was interviewed once during the season.

Statistical analysis

Survey data were analyzed using Statistics 8.1 software, with simple means and percentage graphs utilized as needed.

Management of mango fruit borer

Survey for alternate hosts of mango fruit borer

This study was carried out in three main districts of Punjab, Pakistan, including Multan, Khanewal, and Muzaffargarh. Six tehsils named Multan, Shujabad, Jalalpur Peerwala, Muzaffargarh, Kabirwala, and Khanewal were selected. Three orchards from each tehsil were randomly chosen. Five different hosts from each orchard, whether inside or outside the orchard, were observed for infestation by the mango fruit borer on each host.

Monitoring of mango fruit borer moths through light traps

Light traps were installed in two different mango orchards to monitor moth emergence on a weekly basis. The light traps were installed in mango orchards at Chak 5 Faiz, Multan, and Salarwahin, Khanewal. A funnel-type

light trap was used to monitor the population of mango fruit borers in mango orchards. A light source was suspended over a funnel, which tapered into a chamber beneath it. As the insects entered the chamber through the funnel, they could not escape. It consisted of a galvanized iron funnel 30 inches long, with one end having a 12-inch diameter and the rear end a 3-inch diameter pipe. Perpendicular and beneath the main funnel, a rectangular funnel was placed, which in turn received a jar with a killing agent. Moths from both light traps were transferred to plastic jars and the population of mango fruit borers and other moths was counted.

Varietal preference of mango fruit borer

Selection of orchard

An orchard with multiple varieties of mango was selected based on our survey data with previous history of mango fruit and shoot borer attacks from Multan, Muzaffargarh, and Khanewal.

Sampling method

Mango orchards were selected from three districts (Multan, Khanewal, and Muzaffargarh). Furthermore, six cultivars were selected from each mango orchard. The mango varieties were Sindhri, Kala Chaunsa, White Chaunsa, Anwer Ratool, Mosmi Chaunsa, and Doseri. Five trees were selected from each variety, and the population of infested fruits was counted from all sides of the trees (East, West, North, and South). A quadrate of two square feet was used. The total number of fruits and infested fruits were counted within the quadrate. Data were collected based on visual observations. Damaged fruits were collected and taken to the laboratory for further analysis. Twenty orchards were selected from each district. Infestation percentages were calculated with the help of SPSS software.

Chemical efficacy of insecticides against mango fruit borer

Study area

Screening studies on the efficacy of insecticides against mango fruit borer were conducted in 2019 at Gardezi Farm, Multan. Commercial formulations of the insecticides commonly recommended against lepidopteran insect pests were obtained from the commercial market.

Pre-treatment data

Twenty-one mango trees were selected for chemical treatment prior to pesticide application. All trees were tagged using tagging cards. Three trees were allocated to each treatment group, and three branches were selected from each mango tree. Data on infested fruit were collected from each branch and recorded. After the application of pesticides, the branches were tagged to facilitate comparison of chemical efficacy within the same branch.

Application of insecticides

Selected mango trees were sprayed using a knapsack generator sprayer. The sprayer machine was calibrated before the application of insecticides to ensure its effectiveness. During calibration, it was determined that each tree required 12 liters of water for complete spray application. The doses of insecticides were measured according to the requirement of 12 liters of water per tree.

Post-treatment data

Mortality data of mango fruit borers were recorded from selected mango fruits 72 hours after the application of insecticides. Any new damage caused by mango fruit borers was observed. Selected fruits were then cut using a hand knife to assess the mortality of mango fruit borers resulting from the application of insecticides.

Data analysis

Mortality data were calculated, and percent mortality was determined using statistical software version 8.1.

RESULTS

Survey results

Perception survey results of mango growers from three districts of Punjab regarding various aspects of mango fruit borer and its management are presented below. Key findings of the survey are summarized in Tables 1, 2, and 3.

Ownership

The survey concluded that 62% of mango orchards were managed by tenants, while 32% were managed by the owners themselves. Additionally, it was found that 6% of mango orchards were managed on a share basis within the selected three districts.

Farm size of respondents

Table 1 displays the results of mango growers' land holdings categorized into six groups. The first category comprises growers with a total area of 1-12 acres, representing 56% of mango growers. The second category, with a range of 13-24 acres, accounts for only 14% of mango growers. In the third category, 16% of mango growers possess 25-36 acres. The fourth category includes 4% of growers with 49-60 acres of land. The fifth category consists of only 2% of mango

growers with an area ranging from 61-72 acres. Finally, in the last category, 8% of mango growers possess more than 96 acres of land. The survey noted that the majority of mango growers own land between 1-12 acres.

Table 1: Basic demographic background of the farmers surveyed.

Parameters	Multan (%) ∑=50	M. Garh (%) ∑=50	KWL (%) ∑=50	Total (%) ∑=150
Age				
01-20	6	20	22	16
21-40	46	50	36	44
41-60	44	30	34	36
> 60	4	0	8	4
Qualifications				
Illiterate	8	34	24	22
Up to Middle	52	42	44	46
Matric	26	14	20	20
Intermediate	6	4	2	4
Graduation	8	6	10	8
Ownership				
Owner	46	16	34	32
Tenant	52	76	58	62
Sharing	2	8	8	6
Farm size (acres)				
1-12	44	68	56	56
13-24	8	6	28	14
25-36	24	16	8	16
37-48	0	0	0	0
49-60	6	2	4	4
61-72	4	2	0	2
Above 96	14	6	4	8

Variety-wise covered area

According to respondents, Sindhri and Kala Chaunsa are the most extensively cultivated varieties, covering approximately 32% of the orchards. In contrast, Anwer Ratool, Doseri, and mixed Desi varieties cover around 26%, 2%, and 6% of the area, respectively.

Farmers' perception regarding the most attacked variety of mango

The majority of respondents from all three districts believed that the Sindhri cultivar was the most susceptible to mango fruit borer attacks. Approximately 48%, 38%, and 34% of respondents from Multan, Khanewal, and Muzaffargarh, respectively, identified Sindhri as the most susceptible variety. Moreover, approximately 38%, 32%, and 25% of respondents from these districts believed that Kala Chaunsa was the most affected by mango fruit borer.

Approximately 10%, 18%, and 26% of respondents from Multan, Khanewal, and Muzaffargarh, respectively, believed that Anwer Ratool was the most attacked variety. Additionally, approximately 4%, 2%, and 12% of respondents from these districts identified Doseri as the most affected variety, while around 6%, 4%, and 2% believed that Mosmi Chaunsa suffered the most attacks.

A breakdown of mango orchard stages during the survey is depicted in the graph. It was observed that 90% of mango orchards were in the fruiting stage, while the remaining 10% were in the non-fruiting stage.

Pruning practices

During this survey, it was observed that 82% of mango growers prune the leaves and branches for better growth of mango trees, whereas 18% of mango growers did not prune the mango orchards.

Source of information

During this survey, it was noted that mango growers used different sources of information. According to the survey,

23% of growers took information from the Agriculture Extension department, 18% from pesticide dealers, 17% from neighboring farmers, 12% from private consultants, and 10% used conventional methods. Meanwhile, only 8% of growers obtained information from print media, and 2% from electronic media.

Mango fruit borer attack

During this survey, it was observed that 84% of mango orchards were infested with mango fruit borer attack, while 16% of orchards had zero attacks of mango fruit borer. Mango fruit borer infestation was observed by respondents in districts Muzafargarh, Multan, and Khanewal as 90%, 74%, and 88%, respectively.

Perception about which month mango fruit borer attacks

It was noted that 48% of growers believed that during the months of April-May, mango fruit borer attacks reached their peak. Meanwhile, 30% of growers believed that May-June were more critical than any other months. Whereas, 16% of respondents believed that it attacked in the months of March-April.

Perception about the susceptible stage of mango

Farmers' perceptions regarding the time of attack of mango fruit borer on mango plants varied among the farmers of each district. The majority of farmers in all three districts believed that it attacks during the months of April-May, with percentages of 48%, 54%, and 42% in Khanewal, Multan, and Muzaffargarh, respectively. Following that, May-June was believed to be the critical period by 28%, 32%, and 30% of farmers in Khanewal, Multan, and Muzaffargarh, respectively. The percentages of farmers who believed that it attacks in March-April were 18%, 10%, and 22%, and in June-July were 8%, 6%, and 10% in Khanewal, Multan, and Muzaffargarh, respectively.

Table 2: Farm practices adopted by respondents.

Parameters	Multan (%) ∑=50	M. Garh (%) ∑=50	KWL (%) ∑=50	Total (%) ∑=150
Fertilizers				
Urea	78	50	58	62
Urea + DAP	22	12	8	14
Urea+ NP	0	2	4	2
FYM	0	8	4	4
SOP	0	4	14	6
Others	0	2	4	2
No	0	22	8	10
Pruning of orchards				
Yes	88	76	82	82
No	12	24	18	18
Source of information for farm management practices				
Conventional	6	8	16	10
Neighborhood	2	26	26	18
Extension Department	40	16	10	22
Print Media	12	6	6	8
Electronic media	12	4	20	12
Private consultant	22	10	4	12
Pesticide's dealer	6	30	18	18

Susceptible stage for mango fruit borer attack

During this survey, it was noted that 84% of people believed that mango fruit borer attacks during the fruiting stage, while 14% believed it occurs during fruit setting and then moves into the fruits. Only 2% of people thought it attacks the leaves. Similarly, 88% of mango growers in district Khanewal believed it attacks during the fruiting stage, while 10% believed it occurs during the malformation stage, and only 2% believed it attacks the leaves. Additionally, 80% of mango growers in district

Multan and 82% in Muzafargarh observed that mango fruit borer causes damage during the fruiting stage.

How many years has mango fruit borer attack been observed?

During this survey, it was noted that 42% of growers believed that mango fruit borer has been attacking mango orchards for the past three years, while 34% believed it has been happening for the past two years, and 24% perceived that it began damaging mango fruit just last year.

Table 3: Knowledge of respondents about mango fruit borer.

Parameters	Multan (%) ∑= 50	M. Garh (%) ∑=50	KWL (%) ∑ = 50	Total (%) ∑ = 150
Did you know about mango fruit borer attack?				
Yes	74	90	88	84
No	26	10	12	16
In which month mango fruit borer attack observed in mango orchards?				
March-April	10	20	18	16
April-May	54	42	48	48
May-June	32	30	28	30
July-August	4	8	6	6
Which stage you observed mango fruit borer attack in your orchard?				
Fruiting	80	82	88	84
Malformation	20	14	10	14
Leaves	0	4	2	2
How you manage mango fruit borer in your orchard?				
Insecticides	82	82	70	78
No	6	8	28	14
Others	12	10	2	8
Which insecticide applied against mango fruit borer?				
Bifenthrin	36	52	32	40
Emmamectin	36	20	28	28
Imidacloprid	10	10	10	10
Others	12	10	2	8
No control	6	8	28	14
Which variety infested by mango fruit borer?				
Sindhri	48	34	38	40
Black Chaunsa	32	26	38	32
Anwar Ratool	10	26	18	18
Doseri	4	12	2	6
Mosmi Chaunsa	6	2	4	4
How many numbers of chemical sprays applied against mango fruit borer?				
1	42	28	44	38
2	56	60	40	52
3	2	12	10	8
4	0	0	6	2

Management methods used by mango growers

During this survey, it was noted that 78% of mango growers used insecticides in their mango orchards to manage the infestation caused by the mango fruit borer, while 14% of mango growers did not use any management practices to control the population of the mango fruit borer. It was also observed that 8% of mango growers used other methods, such as placing Ak plant

leaves between the mango fruits, to control the mango fruit borer. The majority of farmers rely on chemical insecticides for its management, with 60% in Khanewal, and an equal proportion of 80% in both Multan and Muzaffargarh. Respondents from Khanewal (28%), Multan (8%), and Muzaffargarh (10%) reported that they do not apply any control measures for mango fruit borer.

Which chemical was mostly used by mango growers?

During this survey, it was noted that 40% of mango growers used bifenthrin as a chemical in their orchards to control mango fruit borer. Meanwhile, 28% of growers used emamectin benzoate, 8% used imidacloprid, and 2% used other methods to control mango fruit borer attacks in their orchards. Additionally, 14% of growers did not use any single insecticide for managing mango fruit borers.

Most mango growers in the Khanewal district (32%) used bifenthrin to manage the population of mango fruit borers, while 28% of growers prioritized emamectin benzoate. Conversely, 52% of mango growers in the Muzaffargarh district used bifenthrin, and 36% of mango growers in Multan used bifenthrin insecticides.

Regarding emamectin, 28% of growers in Khanewal, 36% in Multan, and 20% in Muzaffargarh used it. However, it is also concerning that 26% of mango growers in the Khanewal district did not use any single method to control the population of mango fruit borers.

Host range observed by mango growers

During this survey, it was noted that none of the respondents were aware of the host ranges of mango fruit borer due to a lack of proper awareness.

Damage percentage perception

During this survey, it was noted that mango fruit borer caused damage mostly within the range of 21-30% in mango orchards. Specifically, 58% of growers believed that mango fruit borer damage falls within the 21-30% range, while 18% believed it falls within the 11-20% range, and 14% believed it falls within the 31-40% range.

Number of chemical sprays applied for the management of mango fruit borer

During this survey, it was noted that 52% of mango growers applied insecticides twice in their mango orchards for mango fruit borer management, while 38% applied them once, and 2% applied pesticides four times to suppress the mango fruit borer population.

Management of mango fruit borer

Infestation of mango fruit borers on other host plants outside mango orchards

Results of host plants survey showed that maximum infestation of mango fruit borers were observed on falsa (6.9%), jaman (3.04%), broad leaved weeds (1.9%) and guava (0.4%). Although infestation was not too much high, but it was enough to support the insect pest to survive during off season (Figure 1a).

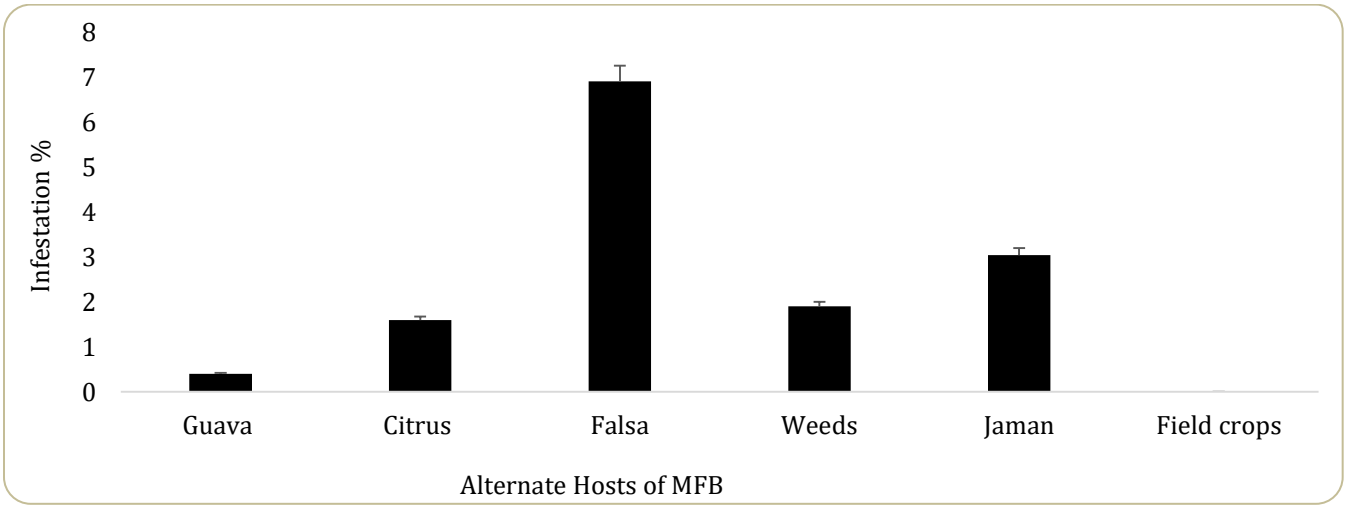

Figure 1a: Infestation (%) of mango fruit borer on alternate hosts outside mango orchards.

Infestation of mango fruit borers on other host plants inside mango orchards at different locations

Host plants data showed that mango fruit borers were present on different crops grown inside the orchards. It was observed on falsa plants at eight sites with 5-27 % infestation, on Jaman at four sites with 6-23%

infestation, on guava at one site with 5% infestation, at three sites on citrus with 4-12 %, on weeds at 4 sites with 6-12 % and no infestation was found on field crops like maize, wheat, and fodder crops grown inside orchards out of 18 sites observed from three districts i.e., Multan, Khanewal and Muzaffargarh (Figure 1b).

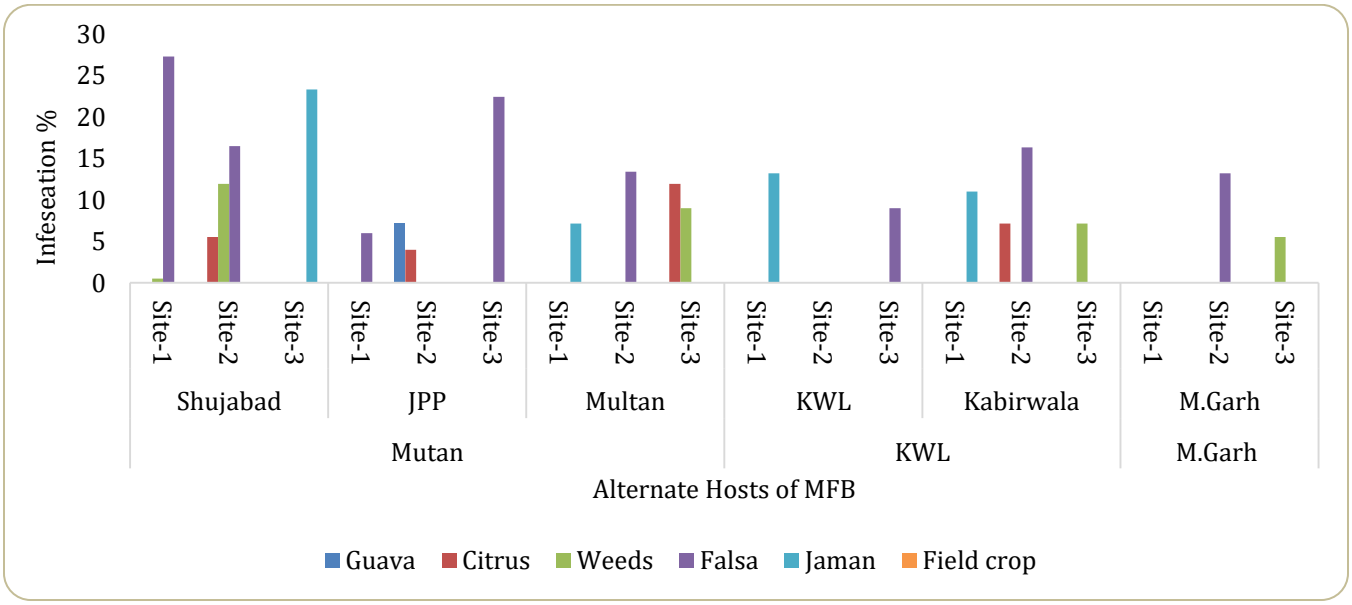

Figure 1b: Infestation (%) of mango fruit borers on other host plants inside mango orchards at different locations.

Monitoring of mango fruit borer moths through light traps

Mango fruit borer moth's population varied in different weeks of mango growing season of 2019-20. Counting of moth's population was started from the first week of January, 2020 to the last week of December, 2020. During this study, it was noted that maximum moths of mango fruit borer population were recorded during the 2nd week of April at Multan while the maximum population of moths was recorded in Khanewal during the 3rd week of April. First time moths' population of mango fruit borer observed during the 2nd week of February. There was no population from October to February (Figure 2 and 3).

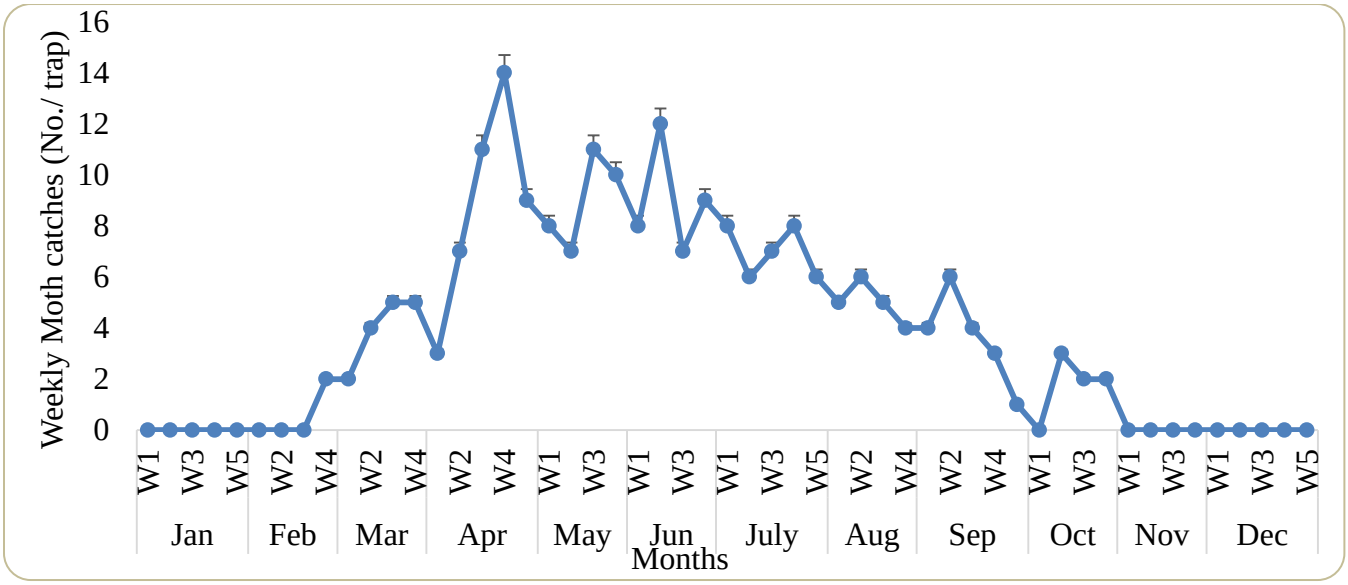

Figure 2: Mango fruit borer moth catches in Multan, 2020.

Varietal preference of mango fruit borer

Fruit borer attack was found on almost all commercial varieties of mango with different level of infestation i.e., Sindhri (29.9 %), Kala Chaunsa (24.9%), Late Chaunsa (22.4), Anwar Ratool (19.3%), Summer Bahisht (Mosmi) (14.3%), and Doseri (12.6%) (Figure 4).

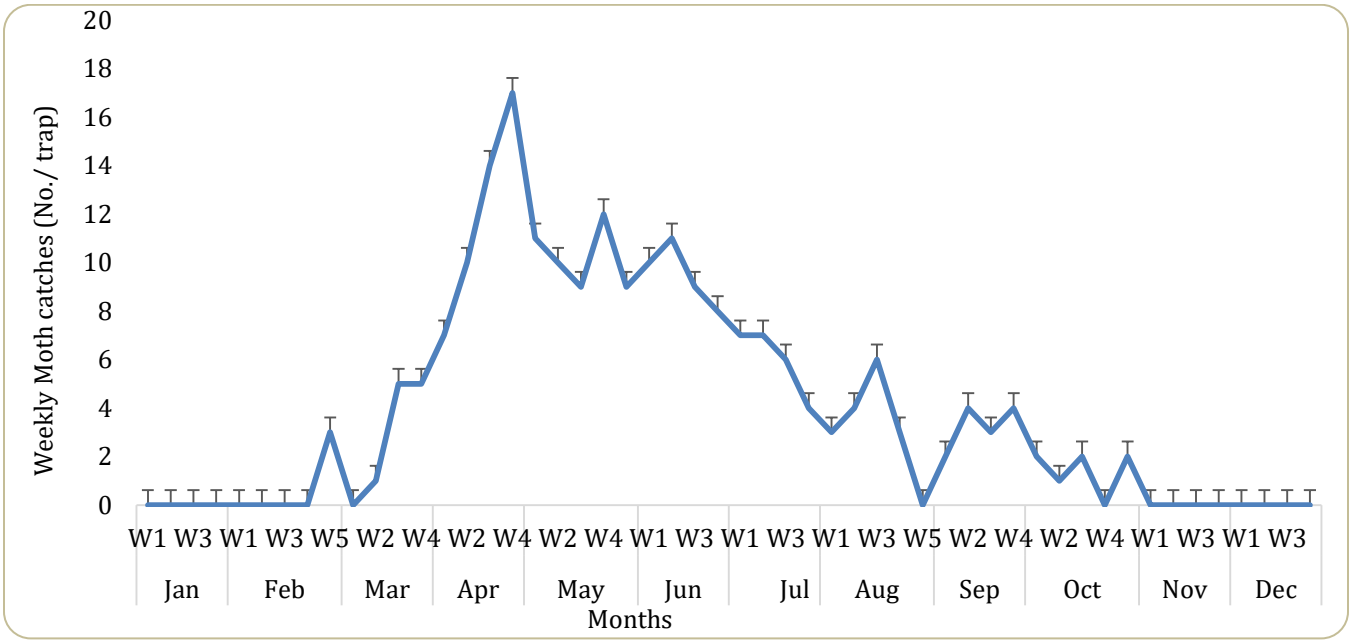

Figure 3: Mango fruit borer moth catches in Khanewal, 2020.

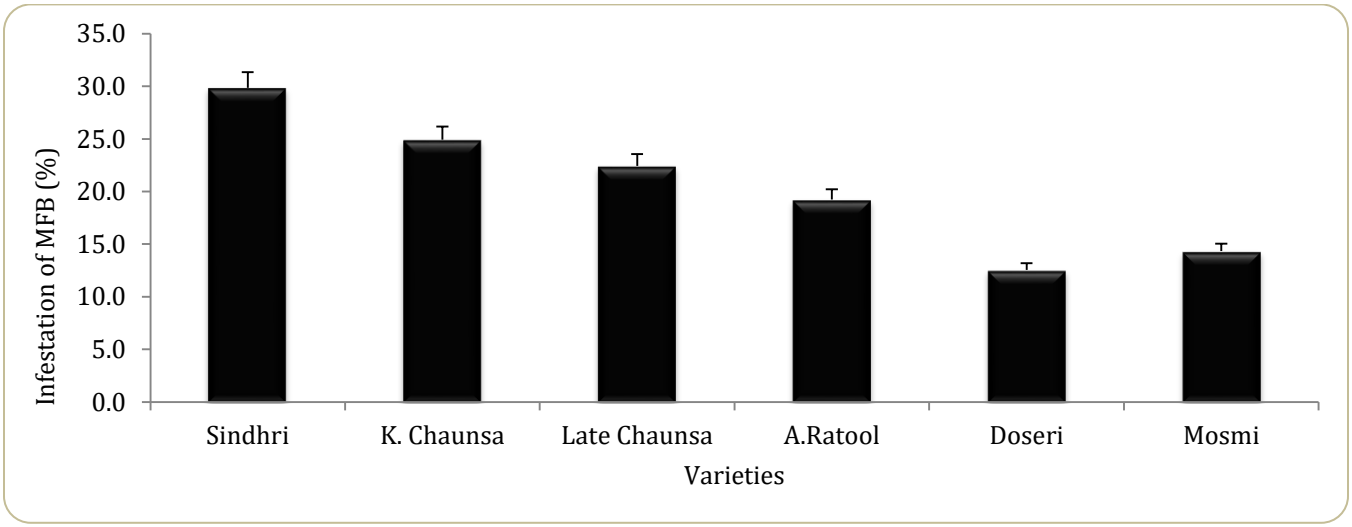

Figure 4: Varietal preference of mango fruit borer.

Varietal preference of mango fruit borer (Districts wise)

District-wise comparisons of mango fruit borer infestation are detailed in Figure 5. Fruit borer attacks were observed on almost all commercial varieties of mango in Khanewal district, with varying levels of infestation: Sindhri (28.26%), Kala Chaunsa (24.19%), Late Chaunsa (20.98%), Anwar Ratool (19.33%), Summer Bahisht (Mosmi) (16.75%), and Doseri (11.93%). Similar attacks were found on nearly all commercial mango varieties in Muzaffargarh district, with the lowest incidence observed on the Doseri cultivar. Specifically, Sindhri fruits exhibited 30.74% damage, while Kala Chaunsa had 25.91%, Late Chaunsa 25.11%, Anwer Ratool 19.59%, Doseri 9.66%, and Mosmi Chaunsa 14.81% damage.

In Multan district, attacks were also prevalent across various mango varieties, with the least damage observed on the Mousmi Chaunsa and Doseri cultivars at 11.75%. The highest fruit infestation rates were recorded in Sindhri (30.49%), Kala Chaunsa (23.86%), Late Chaunsa (21.23%), Anwer Ratool (18.87%), Doseri (11.75%), and Mosmi Chaunsa (11.27%).

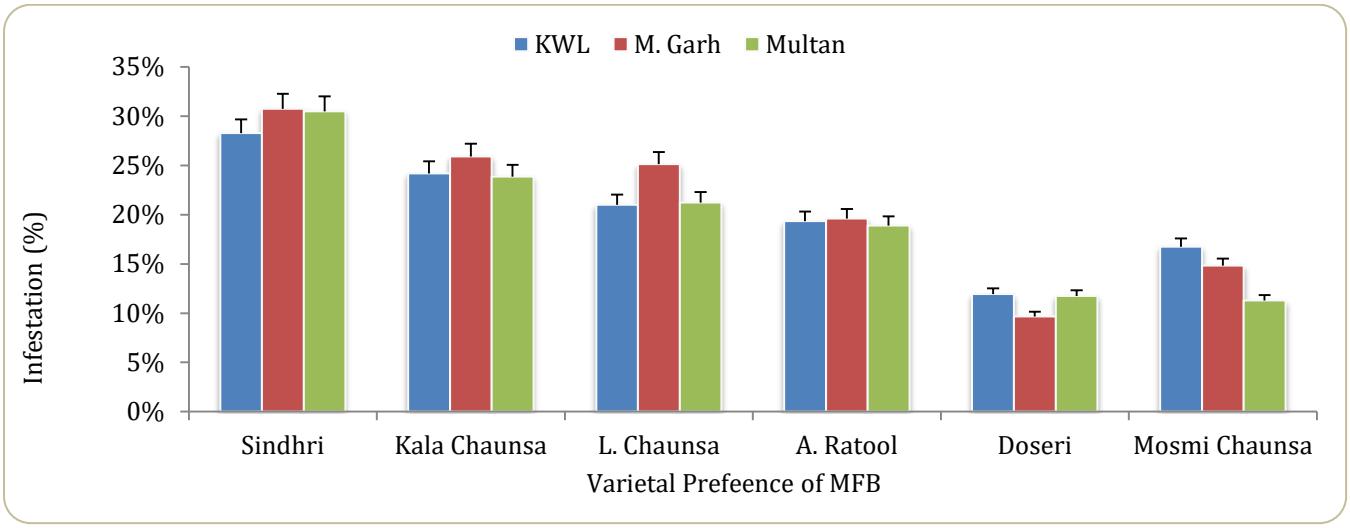

Figure 5: District wise comparison of percent Infestation of mango fruit borer for varietal preference.

Chemical efficacy of different insecticides against mango fruit borer

The toxicity of chemical pesticides revealed that the most toxic insecticide was bifenthrin at 250 ml, followed by emamectin benzoate at 200 ml, Coragen (chlorantraniliprole) at 50 ml, lufenuron at 200 ml, Radiant (spinetoram) at 100 ml, and Voliam flexi (thiamethoxam + chlorantraniliprole) at 80 ml per 100 L of water. Mortality data against mango fruit borers suggested that the highest mortality was observed with bifenthrin (67.17%), followed by emamectin benzoate (57.37%), Coragen (53.84%), lufenuron (47.26%), spintoram (33.6%), and Voliam Flexi (26.19%). Emamectin benzoate, Coragen (chlorantraniliprole), and lufenuron could be good options compared to synthetic pyrethroids (such as bifenthrin) because these insecticides are relatively safe for natural enemies and pollinators (Figure 6).

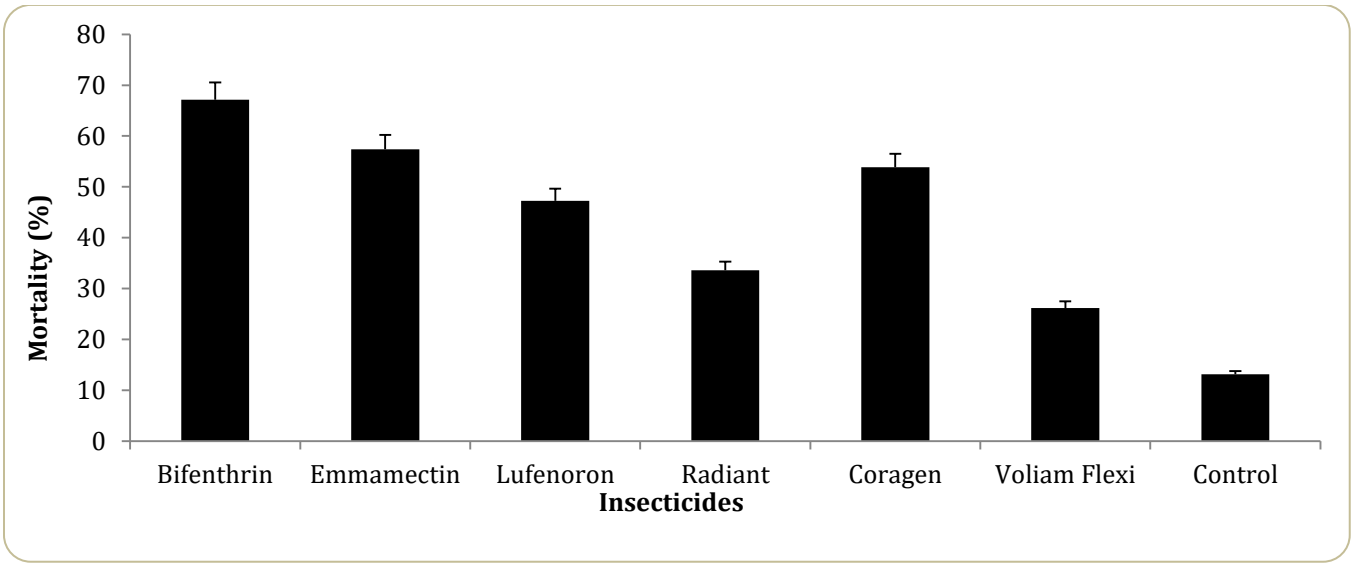

Figure 6: Effect of insecticides on the mortality (%) of mango fruit borer.

DISCUSSION

All stages of mango fruits are susceptible to the mango fruit borer. Fruit damage can be easily observed by the black sap running out from the entry hole made by the caterpillar. This sap becomes noticeable after a few days (Fenner, 1997). The larvae mostly enter through a single hole, typically located in the lower half of the fruit (Krull, 2004). The first two instars feed on the pulp of the fruits, while the later instars feed on the inside of the fruit (Waterhouse, 1998). Krull (2004) observed in Papua New Guinea that mango fruits of all sizes were attacked, but pea-sized fruits were preferred sites for oviposition. Sindhri and Chaunsa are the most susceptible cultivars.

According to Qaisar (2018), surveys of different mango orchards have proven to be very fruitful in understanding the basic tactics adopted by mango growers to manage the population of mango fruit borers in their orchards. These surveys were essential for gauging the knowledge and perception of mango growers regarding mango fruit borers. The survey results revealed that damage caused by mango fruit borers was present in the majority of orchards in districts Multan, Muzafargarh, and Khanewal. The primary objective was to explore the management practices employed by growers to control the mango fruit borer population.

During the conducted survey, it was observed that 44% of mango growers fell within the age range of 21-40 years, while 37% were between 41-60 years. Only 15% of growers were in the 10-20 years age group, indicating that most growers were of mature age. Interestingly, all interviewees were male, and no female mango growers were present in districts Multan, Muzafargarh, and Khanewal.

Furthermore, the survey highlighted that 22% of mango growers were illiterate, while 45% had completed only middle-level education. This lack of formal education might contribute to their limited knowledge and experience in managing insect pests. It is well-established that effective management of insect pests requires a high level of knowledge from growers to achieve optimal crop production. Educated individuals tend to have more innovative ideas and are open to adopting new technologies that can enhance productivity. Madisa et al. (2010) also observed that educated farmers are generally receptive to innovative ideas and positive changes.

This research underscores the emergence of the mango fruit borer as one of the most susceptible insect pests affecting mango fruits. The severity of its attack varies across different mango varieties and fluctuates over time.

Most mango growers perceive that it attacks during the malformation stage, while some growers believe it initially appears on leaves. However, the majority of growers think that the mango fruit borer primarily attacks during the fruiting stage of the mango tree. Among mango varieties, Sindhri and Chaunsa are more susceptible to mango fruit borer than other varieties. Education plays a vital role in the annual income from mango fruits (Qaisar, 2018).

During this survey, it was observed that 62% of mango orchards were tenanted, while only 32% were under ownership. Additionally, 90% of the surveyed mango orchards were in the fruiting stage, while 10% were in the non-fruiting stage. Irrigation practices varied: 64% of mango growers used a 7-day interval, while 36% opted for a 15-day interval. Interestingly, this aligns closely with the 66.7% of mango orchard growers in Multan district who also used a 7-day interval according to Qaisar et al., 2018.

Regarding fertilizers, 62% of growers used only urea, 14% used DAP and Urea, and a mere 4% utilized Farm Yard Manure (FYM). In contrast, Qaisar et al., 2018 reported that 36.7% of Multan district growers used Potash and FYM to enhance mango fruit production. Pruning plays an important role in mango tree management. During the survey, it was noted that 82% of mango growers adopted pruning practices in their respective orchards. The mango fruit borer primarily attacks pea-sized mango fruits. Growers believed that the maximum infestation occurred during the April-May months, while others considered May-June to be more critical. It is essential to recognize that all survey results were collected based on the knowledge of mango growers. However, scientists acknowledge that not every individual possesses adequate knowledge about mango fruit problems and management tactics.

Reducing the communication gap between mango growers and researchers is crucial for establishing effective management tactics and raising awareness among growers about basic Integrated Pest Management (IPM) methods for controlling the mango fruit borer. The findings indicate that while some growers are aware of insect pests like scales and mealy bugs, most of them possess knowledge primarily about mango fruit flies and

mealy bugs. Bridging this communication gap between growers and researchers is essential.

During the conducted survey, it was noted that 78% of mango growers solely relied on chemicals for managing mango fruit borers in their orchards, while 14% of growers did not employ any specific IPM strategy to control the mango fruit borer population. According to Qaisar (2018), 76.7% of growers used chemicals to combat mango fruit borer. Specifically, 40% of growers used bifenthrin, 28% used emmamectin benzoate, and 8% used imidacloprid to tackle the mango fruit borer.

Interestingly, during the survey, no one demonstrated adequate knowledge about the host plant of the mango fruit borer. While 40% of growers assumed that the Sindhri cultivar was more susceptible to mango fruit borer than other varieties, the research revealed that 29.9% of infestations occurred in the Sindhri variety, followed by Kala Chaunsa (24.9%), Late Chaunsa (22.4%), Anwer Ratool (19.3%), Doseri (12.6%), and Mosmi Chaunsa (14.3%).

Consistent with the 2018 survey, Sindhri remains one of the most susceptible cultivars to the mango fruit borer. Additionally, the current study highlights the effectiveness of bifenthrin, which demonstrated 67.17% mortality against the mango fruit borer. Other treatments included Emmamectin benzoate (57.37%), Lufenoron (47.26%), Radiant (33.6%), Coragen (53.84%), and Voliam Flexi (26.19%). Off-season practices also play a vital role in managing the mango fruit borer. Mango growers must remove infested fruits and weeds from the orchards, install light traps to monitor moth populations, and use selective insecticides for better management of mango fruit borers.

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AUTHORS' CONTRIBUTIONS

MI, HA and SS designed the experiment and executed. MI and HA conducted the experiment and wrote the article. UNU and AR helped in the statistical analysis and review the early draft. UF and FB revised the manuscript. All authors approved the final article after reading.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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