Research Article

Fruit Fly Control Practices and Losses in Peach Orchards of Swat District, Khyber Pakhtunkhwa

Arshad Farooq[1], Abdul Hassan[1], Muhammad Ishaq[2] and Asif Nawaz[3]*

[1]PARC Social Sciences Research Institute, Tarnab, Peshawar, Khyber Pakhtunkhwa, Pakistan; [2]Social Sciences Division, PARC, Islamabad, Pakistan; [3]Faculty of Agriculture, The University of Agriculture, Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan.

Abstract | Being a pest of quarantine importance, fruit flies have been considered among top ten world's most severe agriculture pests which cause huge threats worldwide in terms of quantitative and qualitative losses in orchards. In order to assess the losses caused by fruit fly in peach and the control practices adopted against it, a survey was carried out in district Swat. A total of 80 peach growers from four main peach growing tehsils of district Swat (20 sample growers from each tehsil) i.e., Barikot, Kabal, Matta and Khwaza Khela were randomly interviewed. The salient findings of the study revealed that using of pheromone traps is the most key technique adopted by 60% of the sample peach growers for control of fruit fly in peach orchards. Chemical sprays applied by the sample growers on their peach orchards were at an average of 7.75 times. Mean fruit fly losses was noted in the variety of Maria delesia that was 19.97% followed by Indian blood 19.52%, Elberta 16.64%, Suance 14.65%, Flam crest 11%, NJC84 9.05% and Coronetto 7.72% losses were reported by the sample peach growers in the study area. Cleaning of peach orchards from weeds, ploughing, pruning of plants, proper disposal of infected fruits and pheromone traps were the major eco-friendly pest management techniques adopted by the majority of the sample peach growers. High prices of inputs, lack of knowledge, adulteration in pesticides and fruit fly control were the main problems faced by the sample growers in the study area. The study suggested that agricultural departments and other private organizations involved in agricultural development may organize awareness and training programs in the context of integrated pest management techniques (IPM), motivate the farmers to adopt pheromone traps, develop fruit flies control techniques, control the prices and quality of agricultural inputs and also provide subsidy on inputs, develop pest resistant peach varieties, ensure the availability of advanced fruit fly traps.

Received | November 10, 2022; **Accepted** | November 05, 2024; **Published** | January 12, 2025
***Correspondence** | Asif Nawaz, Faculty of Agriculture, The University of Agriculture, Dera Ismail Khan, Khyber Pakhtunkhwa, Pakistan; **Email:** asif.nawaz38300@gmail.com
Citation | Farooq, A., A. Hassan, M. Ishaq and A. Nawaz. 2025. Fruit fly control practices and losses in peach orchards of Swat District, Khyber Pakhtunkhwa. *Sarhad Journal of Agriculture,* 41(1): 78-87.
DOI | https://dx.doi.org/10.17582/journal.sja/2025/41.1.78.87
Keywords | Fruit fly, Pest management techniques, Peach varieties, Pheromone traps, yield losses

Introduction

The climatic condition of Pakistan is very congenial for the production of various types of fruits. The area of the country under fruit crops are 6,78,986 hectares with 73,13,223 tonnes of produce. The area under fruit crops grown in Khyber Pakhtunkhwa is 41,143 hectares with production of 3,42,515 tonnes.

Table 1: *Share of peach fruit area and production of Khyber Pakhtunkhwa, Pakistan.*

Year	Khyber Pakhtunkhwa		Pakistan		Share of Khyber Pakhtunkhwa	
	Area (ha)	Production (tons)	Area (ha)	Production (tons)	% Share in area	% Share in production
2016-17	8690	54553	14385	71639	60.41	76.15
2017-18	9013	56776	14350	72536	62.81	78.27
2018-19	9818	71580	15032	87864	65.31	81.47
2019-20	10028	73198	15055	110880	66.61	66.02
2020-21	10081	69417	15295	110764	65.91	62.67

Source: *GOP, 2019-20 and 2020-21.*

Peach is an important stone fruit of Pakistan and cultivated on 15,295 hectares with production of 1,10,764 tonnes, whereas in Khyber Pakhtunkhwa cultivated area under peach crop is 10,081 hectares with production of 69,417 tonnes as shown in Table 1 (GOP, 2020-21).

Khyber Pakhtunkhwa is the leading fruit producing province of Pakistan. Its shares are 6.06 % and 4.68% of the country total fruit area and production, respectively. Whereas the province share in peach area is 65.91% and production share is 62.67%, respectively during the year 2020-21. Table 2 shows that Swat district is the highest peach producing district of the province in terms of area and production (GOP, 2020-21).

Table 2: *District wise peach fruit area and production of Khyber Pakhtunkhwa (2020-21).*

Districts	Area (ha)	Production (tons)	% Share in area	% Share in production
Swat	7318	48200	72.59	69.44
S. Wazristan	546	2705	5.42	3.89
Peshawar	403	1050	4.00	1.51
Bunir	350	3396	3.47	4.89
Mardan	310	2939	3.08	4.23
Dir Upper	215	1935	2.13	2.79

Source: *GOP, 2020-21.*

Fruits contributed around 13% in the GDP of Pakistan and exports reached up to 2,366.5 billion rupees. Unfortunately, major portion is lost annually during pre-harvest or post-harvest due to pest infestation and provided significant damage to Pakistan economy (Aziz and Hussain, 2018). Numerous pests and diseases pose problems by reducing the profitability of horticulture sector (Ryckewaert *et al.*, 2010). Pest and diseases ignore human political borders (Cayol *et al.*, 2002). Being a pest of quarantine importance, fruit flies have been considered under top ten world's most severe agricultural pests (Tyagi *et al.*, 2016). It causes enormous threats worldwide in terms of quantitative and qualitative losses in horticultural crops (Vasudha and Agarwal, 2019). The fruit flies not only cause direct fruit losses but also reduce the value of the trading and export opportunities due to the strict quarantine regulations (Abro *et al.*, 2017). Also, fruit fly pest affecting local and export markets (Verghese *et al.*, 2002). Reductions in infestation of fruit flies the gross annual saving inferred is Rs. 4915 million and US$ 144.6 million (Stonehouse *et al.*, 2002). Significant income could be generated if the fruits are protected from fruit fly attacks (Karar *et al.*, 2021).

For the control of fruit flies the farmers mostly practiced chemical (Kakar *et al.*, 2014). Mostly rely on the pesticides from Organophasphates group that is extremely hazardous for human health and environment (Rehmat and Nawab, 2019). The use of pesticides for management of fruit fly is not economic, effective and safe (Adhikari *et al.* 2020). Prevalence of diseases and abandoned use of pesticides restrict Khyber Pakhtunkhwa and Pakistan's access to international markets (Rana *et al.*, 2021). Akhtar *et al.* (2019) reported that in Swat district farmers applied 28 pesticides for control of pests in peach orchards. Pesticide residues were detected in 73% of the peach samples (Samad *et al.*, 2019).

The massive thrust to increase the export of fruit and vegetables from Pakistan to new and existing markets may suffer a serious setback unless the government finds a solution to pest attack other than pesticides. Finding sustainable solutions to pest control is the top research priority. Integrated Pest Management (IPM) is a sustainable approach of pest control, contributing to reduced pesticides application and risks on human health and the environment (Allahyari *et al.*, 2017). The eco-friendly pest management techniques throughout the world are increasing without

disturbing the balance of the eco-system (Bhagat *et al*., 2013). Worldwide pesticide application has gradually increased over the past decades. There is dire need to practice integrated pest management approaches to reduce dependency on chemical pesticides (WHO–FAO, 2019). Keeping in view the above facts this study has being designed with the objectives to find fruit fly control practices adopted by farmers, fruit fly losses in peach fruits and suggest recommendations for further improvement.

Materials and Methods

Location of the study

This study was conducted in district Swat of Khyber Pakhtunkhwa province because Swat is one of the prominent fruits growing area of the province. Before data collection, a consultative meeting was held with the respective District Director of Agriculture Extension department regarding selection of peach growing areas for data collection. After consultative meeting, four tehsils such as Barikot, Kabal, Matta and Khwaza Khela were purposively selected for data collection because peach is mainly grown on a large scale in these four tehsils of the district.

Sample selection

This study was carried out in four tehsils i.e., Barikot, Kabal, Matta and Khwaza Khela of district Swat, Khyber Pakhtunkhwa. Due to scarcity of resources, eighty (80) peach growers (Twenty for each tehsil) were randomly interviewed from different villages of the respective tehsils with a view to represent the research area.

Data collection

The present study is based on primary and secondary data. The primary data was directly obtained from peach growers of district Swat, Khyber Pakhtunkhwa through a well-structured interview schedule. Secondary data were collected from several published and unpublished sources i.e., research articles, government records, statistical reports and websites. The interviews were conducted in the month of March, 2022 after pre-testing of interview schedule in the field. At the beginning of the interview, aims and objectives of the study were explained to the respondents. This helped in developing a rapport with them for obtaining accurate information from sample peach growers. The respondents were generally interviewed at their farms, residences/hujras. During the survey, the respondents were assured that the data collected would be used only for research and could not be used for any other purpose.

Data analysis

The collected data were fed to the computer. Keeping in view the requirements of the study, simple statistical techniques like averages, cross tabs and percentages were calculated through statistical software statistical package for social sciences (SPSS).

Limitation of the study

In the study area, peach growers had no written records of their farms and the information obtained was based on their reminded memories and estimates. Due to lack of financial and human resources the study restricted to eighty peach growers.

Results and Discussion

Peach cultivars grown

District Swat enjoys the central position in Khyber Pakhtunkhwa regarding production and supplying of high quality peach fruit throughout the growing season. During the research study, farmers were inquired about the cultivation of peach cultivars and area allocation to each variety. The peach growers replied multiple responses regarding cultivation of peach varieties and area allocation as indicated in Table 3. It was recorded that majority of peach growers have grown more than one variety such as early, medium and late season varieties on their farms. It was remarkable that thirteen peach varieties were grown by the sample peach growers in the research area. In the study area, it was found that all the sampled peach growers replied multiple responses about peach varieties grown by them on their farms such as (48) responses obtained about the cultivation of Indian blood (No. 8) peach variety and the growers allocated on average 3.72 acres of land to this variety and obtained yield of 10,022 kg per acre followed by 36 numbers of responses regarding NJC 84/Dobar (No. 5) variety and the peach growers devoted 1.82 acres land to NJC 84/Dobar (No. 5) variety with a yield of 9,821 kg per acre. Similarly 34 numbers of responses noted about early grand variety and peach growers allocated 2.16 acres land and the growers obtained yield of 9,488 kg per acre, variety Suance (No. 6.5) number of responses were 24 and allocated area was 2.58 acres and received yield of 9,339 kg per acre, variety Maria delesia (No. 7) number of

Table 3: *Peach cultivars, area (acres) and yield (kg/acre).*

Varieties	Frequency	Minimum	Maximum	Mean	Std. Dev.	Yield (kg/acre)
Multiple responses of 80 peach growers						
Early varieties						
Early grand	34	0.36	13.0	2.16	2.710	9488
Florida king	7	0.37	17.65	3.98	6.113	8025
Spring crest	3	0.50	1.50	1.08	0.520	11667
Variety No.2	16	0.50	11.18	2.87	2.933	11744
Variety No.3	16	0.24	4.0	1.20	1.202	7461
Carmon (No.4)	12	0.31	3.53	1.35	0.903	13916
Mid varieties						
Coronetto No.(4.5)	13	0.46	8.82	2.26	2.157	11143
NJC 84/ Dobar (No.5)	36	0.25	5.0	1.82	1.298	9821
Flam crest (No. 5.5)	11	0.19	11.76	2.41	3.188	9108
Elberta (No. 6)	12	0.38	4.71	1.46	1.328	10765
Suance (No. 6.5)	24	0.55	14.71	2.58	2.947	9339
Late varieties						
Maria delesia (No. 7)	23	0.23	7.50	1.92	1.946	12609
Indian blood (No. 8)	48	0.40	47	3.72	6.852	10022

Source: *Field Data, 2022.*

responses were 23 with yield of 12,609 kg per acre and peach growers allocated 192 acres to this variety, variety No. 2 and No. 3 were found 16 each multiple responses and the peach growers allocated 2.87 acres and 1.20 acres with yield of 11,744 kg per acre and 7,461 kg per acre, variety Coronetto No. (4.5) responses number were 13 and the peach growers allocated 2.26 acres with yield of 11,143 kg per acre, variety Carmon (No. 4) and variety Elberta (No.6) were noted 12 each multiple responses and peach growers allocated on average 1.35 acres and 1.46 acres with yield of 13,916 kg per acre and 10,765 kg per acre, variety Flam crest (No. 5.5) number of responses were 11 and area allocated to this variety was 2.41 acres with yield of 9,108 kg per acre, variety Florida king number of responses were 7 and devoted area was 3.98 acres with yield of 8,025 kg per acre, while 3 number of responses received from variety Spring crest and area devoted to this variety was 1.08 acres with yield of 11,667 kg per acre. Our results are similar with Palwasha *et al.* (2022) who found that Indian blood (No. 8) and NJC 84 (No. 5) were the most popular varieties and grown by 46% and 27% of the sample respondents in district Swat. Akhtar *et al.* (2019) reported 12 peach varieties cultivated by the farmers in Swat district.

Awareness and source of information about pheromone traps

Awareness and first-hand information source regarding pheromone traps are presented in Table 4. The data exhibit that incredible majority (96.2%) of the peach growers were aware about pheromone traps from various sources and only 3.8% of the peach growers were not aware about pheromone traps and their importance in control of fruit fly in the study area. Table 4 further reveals those growers who were aware and obtained first hand information source from various sources. The results reveal that 43% of the peach growers received first hand information from agricultural extension department regarding pheromone traps and their importance in control of fruit fly in peach orchards followed by fellow farmers (41.5%), pesticides dealers (13%) and agricultural research institutes (2.5%) in the study area.

Table 4: *Awareness and first-hand information obtained about pheromone traps.*

Awareness about fruit fly traps	Frequency	Percent
Yes	77	96.2
No	3	3.8
Sources of first-hand information		
Agricultural research institutes	2	2.5
Agricultural extension department	33	43.0
Fellow farmers	32	41.5
Pesticides dealers	10	13.0
Overall	77	100

Source: *Field Data, 2022*

Pheromone traps used for control of fruit fly

In the study area, use of pheromone traps is the most key technique adopted by majority (60%) of the sample peach growers for control of fruit fly in their peach orchards (Table 5). Of the total 80 sample respondents, 48 sample peach growers installed two types of traps such as pheromone traps and plastic bottle pheromone traps. The data reveals that bulk (40%) of the sample peach growers installed pheromone traps in their peach orchards, while 11.2% of the sample peach growers installed both traps such as plastic bottle pheromone traps + pheromone traps and 8.8% of the growers installed only plastic bottle pheromone traps for control of fruit fly in the study area. It was astonishing that 40% of the peach growers did not use traps for control of fruit fly in their peach orchards in the study area. During discussion with farmers majority of the respondents were of the view that installation of pheromone traps in field like a self invitation to fruit fly to come to our field. The farmers also stated that pheromone traps will work effectively only when all the farmers in the area install the traps on their farms.

Table 5: *Pheromone traps used for control of fruit fly in peach fruit orchards.*

Pheromone traps used	Type of fruit fly traps	Frequency	Percent
Yes	Plastic bottle pheromone traps	7	8.8
	Pheromone traps	32	40
	Plastic bottle pheromone traps + Pheromone traps	9	11.2
All		48	60
No		32	40
Overall		80	100

Source: *Field Data, 2022.*

Awareness and months of pheromone traps installation

Data regarding awareness and months of pheromone traps installation in peach fruit orchards is presented in Table 6. The data reveals that devastating majority (96.2%) of the sample peach growers stated that they were aware about the pheromone traps installation months and only 3.8% of the sample peach growers were not aware regarding the months of pheromone traps installation in peach orchards in the study area. Table 6 further exhibits that 35% of the sample peach growers installed pheromone traps in the month of June whereas 22.5% of the sample peach growers installed pheromone traps in the month of July followed by May (13.8%), August (10%), April (6.2%), May + June (5%), April + May (2.5%) and July + August (1.2%) in the study area. Nahid *et al.* (2020) found the highest population of fruit fly in the months of July and August. Abro *et al.* (2017) reported maximum fruit fly population from mid May to mid June.

Table 6: *Awareness and pheromone traps installation months in peach orchards.*

Awareness	Frequency	Percent
Yes	77	96.2
No	3	3.8
Overall		
If yes pheromone traps installation months		
April	5	6.2
May	11	13.8
April + May	2	2.5
May + June	4	5
June	28	35
July	18	22.5
July + August	1	1.2
August	8	10
Overall	77	96.2

Source: *Field Data, 2022.*

Pheromone traps installed per acre in peach orchards

During the survey it was noted that the sample peach growers installed on average 8.90 numbers of pheromones traps per acre (ranged from 3-27 number traps per acre) in peach orchards (Table 7). In the study area, peach growers installed on average 14.54 numbers of various sizes of plastic bottles pheromones traps per acre (ranged from 3.19-49 numbers traps per acre) in the study area. Table 7 further shows that mean installed height of the pheromone traps in peach orchards was 5.66 feet (ranged from 3-8 feet). Table 7 also further depicts that mean number of days interval for applied chemical in the pheromone traps. During the survey, it was noted that on average the sample peach growers applied chemical in pheromone traps at 10.17 days interval (ranged from 0-30 days interval) in the study area.

Pheromone traps decrease fruit fly infestation and chemical sprays

The data presented in Table 8 reveals that overwhelming majority (85.42%) of the sample peach growers reported that fruit fly infestation decreased while 14.58% of the sample growers mentioned that fruit fly infestation did not decrease after using

pheromone traps in peach orchards. More than half (54.17%) of the sample peach growers stated that they did not decrease the number of chemical sprays application whereas 45.58% of the sample peach growers mentioned that they reduced number of chemical sprays application after installation of pheromone traps in peach orchards in the study area.

Table 7: *Pheromone traps installed per acre, height and chemical applied (mean).*

Types of traps	Minimum	Maximum	Mean	Std. Dev.
Pheromone traps	3	27	8.90	5.290
plastic bottle pheromone traps	3.19	49	14.54	14.159
Height (feet) of pheromone traps hanged in orchards	3	8	5.66	1.123
Chemical applied in pheromone traps (days)	0	30	10.17	5.796

Source: *Field Data, 2022.*

Table 8: *Pheromone traps decreased fruit fly infestation and chemical sprays.*

Fruit fly infestation decreased	Frequency	Percent
Yes	41	85.42
No	7	14.58
Overall	48	100
Number of chemical sprays decreased after installation of pheromone traps		
Yes	22	45.83
No	26	54.17
Overall	48	100

Source: *Field Data, 2022.*

Fruit fly losses in peach cultivars

Being a pest of quarantine importance, fruit flies have been considered under top ten world's most severe agriculture pests (Tyagi *et al.*, 2016). Among the fruit flies species, Bacterocera zonata is a serious pest of fruits causing severe losses to the fruit production and quality in Pakistan (Khan and Naveed, 2017). The data available in Table 9 are only estimates reported by peach growers in the study area. During the survey, the sample peach growers reported that fruit fly infestation mostly started on medium and late cultivars. In the study area the peach growers faced 19.97% fruits losses in Maria delesia (No. 7) variety and 19.52% fruits losses was accounted in Indian blood (No. 8) variety followed by 16.64% fruit losses in Elberta (No. 6) variety, 14.65% losses recorded in Suance (No. 6.5) variety, 11% fruits losses estimated in Flam crest (No. 5.5) variety and 7.72% fruits losses stated in Coronetto (No. 4.5) variety from fruit fly infestation. Kakar *et al.* (2014) recorded and compared two years fruit fly infestation in peach fruit during 2010 and 2011. The highest fruit fly infestation (23.2%) was recorded in 2010 as compared to the year 2011 (21.2%). Mean values of the data showed that the fruit fly had the maximum infestation in early August (47%) followed by mid-July (41.5%) and mid-August (38.2%). Karar *et al.* (2021) found that late cultivars had more infestation of fruit flies as compared to early and medium cultivars.

Table 9: *Cultivars wise fruit fly infestation in peach fruit (mean percent).*

Varieties	Minimum	Maximum	Mean	Std. Deviation
Coronetto (No. 4.5)	0	15	7.72	5.239
NJC 84/Dobar (No. 5)	0	33	9.05	8.845
Flam crest (No. 5.5)	2	30	11	8.686
Elberta (No. 6)	0	33	16.64	10.522
Suance (No. 6.5)	0	50	14.65	10/896
Maria delesia (No. 7)	0	50	19.97	11.774
Indian blood (No. 8)	0	50	19.52	12.801

Source: *Field Data, 2022.*

Table 10: *Ploughing and weeding/hoeing in peach orchards.*

Ploughing	Frequency	Percent		
Yes	76	95		
No	4	5		
Overall	80	100		
Weeding/hoeing				
Yes	77	96.2		
No	3	3.8		
Overall	80	100		
Ploughing number (mean)	Min.	Max.	Mean	Std. Dev.
	0.0	3.0	1.61	0.646
Weeding/hoeing number (mean)	0.0	3.0	1.33	0.591

Source: *Field Data, 2022.*

Ploughing in peach orchards

Among the integrated pest management (IPM) strategies, cultural control method of insects comprised soil tillage using various ploughing implements to bring insects to surface of soil to expose them to their natural enemies. The ploughing data in Table 10 shows that overwhelming majority (95%) of the sample peach growers perform regularly ploughing

in their peach orchards during summer and winter season. Negligible (5%) of the sample peach growers did not carry out ploughing in peach orchards. On average, sample peach growers applied 1.61 number of ploughing (ranged from 0-3 number of ploughing) in the study area.

Peach orchards maintain and clean from weeds is one of the most important pest management cultural control strategy adopted by 96.2% of the sample peach growers cleaned their peach orchards from weed through weeding/hoeing and 3.8% of the sample growers did not carried out weeding/hoeing practice in peach orchards in the study area. Table 8 further reveals that sample peach growers practices mean number of weeding/hoeing was 1.33 ranged from 0-3 numbers in the study area.

Bordeaux mixture application

During the survey it was noted that majority (83.7%) of the sample farmers did not apply bordeaux mixture on peach trees stem in the study area. It was astonishing that 16.3% of the sample peach growers applied Bordeaux mixture just after trees pruning operation to protect wounds, cure the diseases and kill the insects.

Table 11: *Bordeaux mixture applied and pruning the peach plants.*

Bordeaux mixture applied	Frequency	Percent
Yes	13	16.3
No	67	83.7
Overall	100	100
Pruning the peach plants		
Yes	80	100

Source: *Field Data, 2022.*

Pruning is the management practice to remove unwanted branches from plants and to optimizing yield, improving fruit size and to give proper structure/shape to plants. During survey it was observed that all of the sample growers were pruning peach plants regularly in the study area (Table 11). Rai *et al.* (2022) identified various management practices for controlling of fruit fly like use of pheromone traps, collection and destruction of fallen fruits, pruning and pesticides.

Clean peach orchards from infected dropped fruits

Field sanitation of peach orchard is the cultural method that control and reduce the fruit fly damage indirectly. Field sanitation is necessary because poorly managed or discarded farms result in upsurge of fruit fly populations. During survey it was noted that bulk (85%) of the peach growers were involved in regular collection and disposing of all infected dropped fruits on the ground during the entire season specially those fruits containing fruit fly maggots. Table 12 further shows those growers who collected and disposed infected dropped fruits. It was remarkable that 47.5% of the sample peach growers buried the infected dropped fruits in a deep hole while 36.2% of the growers collected the infected fallen fruits from the ground and throne far away on one side from field. Only 1.2% of the sample peach growers collected the infected dropped fruits and feed to animals. In the study area 15% of the sample peach growers did not take any action regarding removal of infected dropped fruits from peach orchards in the study area. Vincent *et al.* (2004) found that insecticide uses and removal of dropped fruits form orchards significantly reduced the number of fruit flies attacked on fruits.

Table 12: *Clean peach orchards from infected dropped fruits.*

Clean peach orchards	Frequency	Percent
Yes	68	85
If yes clean the orchards what do with infected dropped fruits		
Buried the infected dropped fruits	38	47.5
Feed to animals	1	1.2
Collect and throne on one side	29	36.2
No action	12	15
Overall	80	100

Source: *Field Data, 2022.*

Table 13: *Peach growers used strategies for pesticides effectiveness.*

Strategies	Frequency	Percent
Mix different pesticides	6	7.5
Increase pesticide concentration	10	12.5
Spray more frequently	12	15
Change and spray another pesticides	52	65
Overall	80	100

Source: *Field Data, 2022.*

Strategies used for pesticides effectiveness

To capture the farmers practices about effectiveness of pesticides application in the study area, the data is presented in Table 13. The findings reveal that about two-third (65%) of the sample peach growers change pesticide due to ineffectiveness and spray

another chemical of pesticide for control of insects/pests in peach orchards followed by same spray more frequently (15%), increase pesticide concentration (12.5%) and mix different pesticides (7.5%) for increase of effectiveness in the study area.

Application of chemical sprays

Dormant sprays are applied to control over-wintering insects and prevent diseases infection. It was remarkable that devastating majority (93.8%) of the sample peach growers applied dormant sprays while only 6.2% of the sample farmers did not apply dormant sprays on peach orchards in the study area. On average the numbers of dormant sprays applied on peach orchards was 1.33 numbers (ranged from 1-3 numbers of dormant sprays) Table 14.

Table 14: *Dormant sprays and number of chemical sprays applied on peach orchards.*

Dormant spray	**Frequency**	**Percent**		
Yes	75	93.8		
No	5	6.2		
Overall	80	100		
If yes dormant spray No.	Min.	Max.	Mean	Std. Dev.
Dormant spray No.	1	3	1.33	0.553
Total number of chemical sprays applied on peach orchards				
Chemical sprays number applied	3	18	7.75	2.385

Source: *Field Data, 2022.*

Conventional agriculture is based on a high level of chemical application such as pesticides and fertilizers, leading to serious environmental impacts, health hazards and loss of biodiversity in agro systems. The reduction of pesticide application is a priority for intensively sprayed agricultural systems such as orchards. Table 14 further shows overall number of chemical sprays applied on peach orchards in the study area. The data presented in Table 14 reveals that mean number of chemical sprays applied by the sample farmers was 7.75 numbers (ranged from 3-18 numbers of chemical sprays) on various stages of plant growth and development for control of insects/pests in peach orchards in the study area. During discussion with peach growers, it was noted that majority of the peach growers used chemical sprays one to two pumps regularly in evening for smell only to far away of fruit fly from their peach orchards. Our results are similar with Khan and Khan (2014) who reported that district Swat farmers on average applied 8 number of sprays per season while Palwasha *et al.* (2022) recorded 24-30 numbers of chemical sprays application per season for control of pests in Malakand division, Khyber Pakhtunkhwa.

Problems faced by sample peach growers

There are many reasons for low adoption of improved management techniques in the study area as indicated in Table 15. The data exhibits that more than half (51.2%) of the sample peach growers reported high prices of inputs were the main problem that restricted the growers to adopt recommended management techniques followed by lack of improved knowledge/awareness (20%), adulteration in pesticides (17.5%), fruit fly control (5%), high prices of inputs + adulteration in pesticides (3.8%), 1.2% each of the sample peach growers mentioned high prices of inputs + lack of improved knowledge/awareness and agricultural extension workers not paid visits to farms in the study area. Khan and Khan (2014) reported that lack of finance, high price of inputs, low shelf life of peach fruit, pests and natural calamity attack, lack of market information, price fluctuation and high cost of transportation were the major problems faced by the sample farmers in Swat, Khyber Pakhtunkhwa.

Table 15: *Problems faced by sample growers regarding pest.*

Challenges	**Frequency**	**Percent**
High prices of inputs	41	51.2
Adulteration in pesticides	14	17.5
Fruit fly control	4	5
Lack of improved knowledge/awareness	16	20
High prices of inputs+Adulteration in pesticides	3	3.8
High prices of inputs + Lack of improved knowledge/Awareness	1	1.2
Agri. Ext. Workers do not paid visits to farms	1	1.2
Overall	80	100

Source: *Field Data, 2022.*

Conclusions and Recommendations

Peach is an important cash crop and main source of income in district Swat and the sample peach growers allocated major portion of their operational land to peach orchards. Majority of the sample peach growers cultivated more than one peach variety on their farms including early, medium and late varieties to cover the entire peach fruiting season and to fetch better prices of their produce. The findings exhibited that

fruit fly is a dilemma and causes significant losses in medium and late peach varieties. The sample peach growers applied various techniques and strategies to control the fruit fly in peach orchards. Peach growers reported high prices of inputs were the major problem that restricted the growers to adopt recommended management techniques of fruit fly control. On the basis of empirical findings, the study suggested that:

- Agricultural Extension Department should aware/educate and motivate the farmers to adopt and install pheromone traps for control of fruit flies and also ensure the availability of advanced fruit fly traps in farm services centers.
- The government should control the prices of agricultural inputs and pesticide quality, and to provide subsidy on these inputs to increase the adoption level of recommended agricultural production technologies and ultimately improve the farms production and living standard of the farmers.
- Regular monitoring system/mechanism needs to be introduced by the Agricultural Research Institutes to identify fruit fly species availability in the fruits and vegetable growing areas and also needs to develop fruit flies control techniques.
- Agricultural research institutes needs to develop high yielding and insects/pests resistant peach varieties best suited to the agro ecological condition of the area.

Acknowledgements

Authors acknowledge the support of Pakistan Agricultural Research Council for their support.

Novelty Statement

This research study provides a comprehensive assessment of fruit fly damage and control practices in peach orchards of district Swat, highlighting the widespread use of pheromone traps and the eco-friendly pest management strategies adopted by growers.

Author's Contribution

Arshad Farooq: Designed the research study, literature review, developed and pre tested interview schedule, collected the data, entered the data and performed its analysis and then wrote the research article.
Abdul Hassan: Contributed in data collection, data entry, data analysis and report writing.
Muhammad Ishaq: Supervised this research and contributed in designing of the study and also helped in every stage during development of this article.
Asif Nawaz: Contributed in literature review, data analysis and research paper write up.

Conflict of interest
The authors have declared no conflict of interest.

References

Abro, Z.A., N. Baloch, N.H. Khuhro, W.A. Qazi and N.A. Saeed. 2017. Population densities of melon fruit fly Bactrocera cucurbitae (Coquillett) in vegetables agro-ecosystem in District Hyderabad, Sindh, Pakistan. Sarhad J. Agric., 33(2): 331-337. https://doi.org/10.17582/journal.sja/2017/33.2.331.337

Adhikari, D., S.L. Joshi, R.B. Thapa, V. Pandit and D.R. Sharma. 2020. Fruit fly management in Nepal: A case from plant clinic. J. Biol. Contr., 34(1): 8-14. https://doi.org/10.18311/jbc/2020/22833

Akhtar, S., A. Samad, A. Gohar, M.M. Shahid, M. Ishtiaq, A. Sarwer, A. Khan and K. Ahad. 2019. A knowledge, agricultural practices, health and management survey related to pesticide applications in peach orchards of Swat, Malakand. Pak. J. Agric. Res., 33(1): 56-62. https://doi.org/10.17582/journal.pjar/2020/33.1.56.62

Allahyari, M., C.A. Danalas and M. Ebadttalab. 2017. Farmers technical knowledge about integrated pest management (IPM) in olive production. Agriculture, MDPU. pp. 1-9. https://doi.org/10.3390/agriculture7120101

Aziz and M. Hussain. 2018. Fruit pest management in Pakistan: A review. Sci. Inquiry Rev. 2(4): 43-52. https://doi.org/10.32350/sir.24.05

Bhagat, D., S.K. Samanta and S. Bhattacharya. 2013. Efficient management of fruit flies pests by pheromone nanogels. Sci. Rep., 3: 1-8. https://doi.org/10.1038/srep01294

Cayol, J.P., Y. Rossler, M. Weiss, M. Bahdousheh, M. Omari, M. Hamalawi and A. Almunghayyar. 2002. Fruit fly control and monitoring in the Near East: shared concern a regional transboundary problem. Proceeding of the international fruit fly symposium 6-10 May, 2002 stallenbosch, South Africa. pp. 155-171.

GoP, 2019-20. Fruit, vegetables and condiments statistics of Pakistan. Govt. of Pakistan ministry of national food security and research (Economic wing) Islamabad.

GoP, 2020-21. Crops area and production (district wise). Govt. of Pakistan ministry of national food security and research (Economic wing) Islamabad.

Kakar, M.Q., F. Ullah, A.U.R. Saljoqi, S. Ahmad and I. Ali. 2014. Determination of fruit flies (Diptera: Tephritidae) infestation in guava, peach and bitter gourd orchards in Khyber Pakhtunkhwa during 2010 and 2011. Sarhad J. Agric., 30(2): 241-246.

Karar, M.E., F. Alsunaydi, S. Albusaymi and S. Alotaibi. 2021. A new mobile application of agricultural pests recognition using deep learning in cloud computing system. Alexandria Engin. J., 60(5): 4423-4432.

Khan. A. and M. Khan. 2014. Costs of production and marketing of peach in swat Khyber Pakhtunkhwa. Sarhad J. Agric., 30(2): 277-282.

Khan, R.A. and M. Naveed. 2017. Occurrence and seasonal abundance of fruit fly, *Bactrocera zonata* Saunders (Diptera: Tephritidae) in relation to meteorological factors. Pakistan J. Zool., 49(3): 999-1003,

Nahid. S., M.R. Amin, M.M. Haque and S.J. Suh. 2020. Seasonal abundance and infestation of fruit fly on cucumber. Saarc J. Agric., 18(2): 233-241. https://doi.org/10.3329/sja.v18i2.51123

Palwasha, S., U. Din and M. Fahim. 2022. Significance and implications of farming practices, knowledge and methods of disease management in developing countries: A case study of peach farmers in Pakistan. Sarhad J. Agric., 38(2): 595-610. https://doi.org/10.17582/journal.sja/2022/38.2.595.610

Rai, A., L.P. Sah, K. Adhikari and Shrestha. 2022. Farmer's perception of fruit fly *Bactrocera* spp. in mandarin orange and their management in Sankhuwasabha district of Nepal. J. Plant Protect. Soc., 7: 45-52. https://doi.org/10.3126/jpps.v7i01.47287

Rana, A.W., Z. Haq, S. Asghar, Z. Haider and S. Davies. 2021. Assessment of value chain system for horticulture in Khyber Pakhtunkhwa including newly merged districts (Former FATA). Prepared as part of the Technical Assistance to Agriculture Department, Government of Khyber Pakhtunkhwa. International food policy research institute (IFPRI). PACE assessment study. pp. 1-61. https://doi.org/10.2499/p15738coll2.134651

Rehmat, U. and K. Nawab. 2019. Pesticides use in Khyber Pakhtunkhwa Province Pakistan: Present scenario. Int. J. Biosci., 14(2): 197-208. https://doi.org/10.12692/ijb/14.2.197-208

Ryckewaert, P., J.P. Deguine, T. Brevault, J.F. Vayssieres. 2010. Fruit flies (Diptera: Tephritidae) on vegetable crops in Reunion Island (Indian Ocean): State of knowledge, control methods and prospects for management. Fruits, 65: 113–130. https://doi.org/10.1051/fruits/20010006

Samad, A., S. Akhtara, M.M. Shahidb and K. Ahada. 2019. Determination of pesticide residues in peaches by using gas chromatography and mass spectrometric detection. Int. J. Environ. Anal. Chem., 99(14): 1-13.

Stonehouse, J., R. Mahmood, A. Poswal, J. Mumford, K.N. Baloch. Z.M. Chaudhary, A.H. Makhdum, G. Mustafa and D. Huggett. 2002. Farm field assessments of fruit flies (Diptera: Tephritidae) in Pakistan: Distribution, damage and control. Crop Protection. 21: 661–669. https://doi.org/10.1016/S0261-2194(02)00018-2

Tyagi, A., V. Pal and C.S. Prasad. 2016. Use of Eco-friendly traps for the management of fruit flies in mango–A Success story. South Asian J. Food Technol. Environ., 2(2): 413-417. https://doi.org/10.46370/sajfte.2016.v02i02.10

Vasudha, A. and M.L. Agarwal. 2019. Management of Dacine fruit flies (Tephritidae: Dacinae: Dacini) in horticultural ecosystems: A review. J. Entomol. Zool. Stud., 7(3): 33-42.

Verghese, A., H.S. Madhura, P.D.K. Jayanthi and J.M. Stonehouse. 2002. Fruit flies of economic significance in India, with special reference to Bactrocera dorsalis (Hendel) processing's of 6th international fruit fly symposium 6-10 May 2002. Stellwnbosch, South Africa. pp. 317-324.

Vincent, C.U., A.A. Olaniyana, J. Kerb and J. Andirb. 2004. Development of citrus fruit fly control strategies for small-holders in Nigeria. Fruits, 59: 265–274. https://doi.org/10.1051/fruits:2004025

WHO–FAO, 2019. Global situation of pesticide management in agriculture and public health. Geneva: World Health Organization and Food and Agriculture Organization of the United Nations. Licence: CC BY-NC-SA 3.0 IGO.