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Self-Sufficiency Strategies of Extension Workers to Protect Citrus Fruits from Fruit Flies in Bati Kot District, Nangarhar-Afghanistan

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ABSTRACT

Fruit flies are severe pests for citrus fruits, attracted to the scent of citrus and often carrying bacteria, including salmonella, E. coli, and listeria, from one location to another. Salmonella, for example, affects about 40,000 people annually in the USA through contaminated food. While some species of fruit flies can damage citrus fruits, others play a role as pollinators. This study aimed to analyze self-sufficiency strategies extension workers use to protect citrus (sweet orange) from fruit flies in Nangarhar. One hundred twenty respondents from District Bati Kot were selected from a population of 200 using a pre-tested interview schedule. Results indicated that 32% of the growers were aged 40-50, and 55% were illiterate. Among the growers, 33% sought help from the extension department for pest and disease issues, while 17% contacted it for weed control. Only a limited number of growers installed traps in April, and 32% knew which months fruit flies were most active, with 74% identifying June and 26% indicating May. Half the growers used pesticides, while 22% disposed of infected fruits through burial, followed by pheromone traps and cultural practices. A majority (86.5%) were aware of improved citrus varieties, and extension workers were the primary information source for 41% of the respondents. A highly significant association was observed between the average citrus yield and the skills of extension workers in protective measures, as well as between the growers' ages and average yield. The study recommends that extension workers make regular orchard visits to educate citrus producers on fruit fly control, such as mixing a quarter cup of apple cider or white vinegar with a few drops of dish soap. This mixture, which attracts fruit flies and then drowns them by breaking the vinegar's surface tension, is an affordable and effective method. Additionally, extension workers should receive training in Integrated Pest Management (IPM) and other control measures to improve the socio-economic conditions and promote self-sufficiency in sweet orange production.

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Introduction

Agriculture is the most important economic sector for some of the world's poorest nations, such as Afghanistan. A substantial portion of Afghanistan's economic output depends on

agriculture, with the sector providing around 22% of the country's Gross Domestic Product (GDP) in 2023 and employing more than 60% of the workforce, while 70% of rural residents rely on agriculture for their livelihood (Sarwary et al., 2023).

Citrus fruit is a significant evergreen tree within the Rutaceae family, cultivated in tropical and subtropical regions worldwide. Citrus is grown in over 140 countries, with global production reaching 105 million tons. After mangoes, tomatoes, and bananas, citrus fruits are among the most consumed worldwide. These fruits come from small to medium-sized plants rich in vitamins, minerals, dietary fibers, and pectin. They also contain several active phytochemicals, such as phyto-phenolics, flavones, and phenolic acids, which are highly recommended for their health benefits due to biological properties including anti-atherogenic, anti-inflammatory, and anti-tumor effects (Aruoma et al., 2012).

Human beings have used and harvested citrus fruits for medicinal, herbal, and agricultural purposes for centuries. Generally, all citrus fruits have a sweet and sour taste and provide a refreshing juice that is available year-round (Sanofer, 2014).

Historically, citrus is believed to have originated in Southeast Asia and the Malay Archipelago, spreading from northern India to China and southward through Malaysia, the East Indies, and the Philippines by early explorers, traders, and missionaries. Recent evidence suggests that Yunnan Province in southwest China may be the center of origin due to the variety of species found there (Gmitter et al., 2007).

China produced 44.6 million tons of citrus fruit in 2020, accounting for 28.07% of the world's total citrus production, making China the world's largest citrus producer. The top five producing countries represent 59.15% of global citrus production, with Brazil, India, Mexico, and the USA following China. Global citrus fruit production in 2020 was estimated at 158 million tons, a significant increase from 42.1 million tons in 1971, with an annual growth rate of 10.47% in 1980, which declined to 0.47% by 2020 (Knoema, 2021).

Afghanistan ranks 81st globally in citrus production, as reported by Atlas Big in 2021. Afghanistan's fresh citrus market is estimated at 146,828 tons, valued at approximately $57.2 million. Based on available data, Afghan growers contribute only 0.9% of the market's value and produce 1.2% of citrus globally. Afghan producers primarily focus on sour orange production, although the demand for mandarins and sweet oranges exceeds that for sour oranges. In 2013, industrial citrus imports included 1,139 tons of sweet orange juice and concentrate (excluding grapefruit juice and concentrates), with a CIF value of $1.3 million, and 66 tons of citrus jams and jellies valued at $0.2 million. The total volume of imported juice and concentrate corresponds to 2,476 tons of fresh citrus, more than double Afghanistan's total production (Booyens et al., 2015).

In 2020, Afghanistan exported $1.93 million in citrus, making it the 75th largest citrus exporter globally. That year, citrus ranked as Afghanistan's 32nd most exported product. The primary destinations for Afghan citrus exports were Pakistan ($1.56 million), Kazakhstan ($244,000), Senegal ($102,000), Tajikistan ($17,500), and Canada ($10,500). The fastest-

growing export markets for Afghan citrus between 2019 and 2020 were Pakistan ($1.16 million), Kazakhstan ($244,000), and Senegal ($74,200). Afghanistan imported $56.9 million in citrus, making it the world's 47th largest importer. In 2020, citrus ranked Afghanistan's 25th most imported product (OEC, 2020).

Citrus production in Afghanistan's eastern region, including Nangarhar, Kunar, and Laghman, holds great potential, with over 1,700 small producers in the industry. The Nangarhar Valley Development Association (NVDA) manages 2,914 hectares of citrus-growing land, of which 501 hectares are currently productive. A 2014 survey covering four NVDA farms, 1,036 growers, and around 60% of local citrus growers indicated fragmented, small production units with an average size of two jeribs (0.4 hectares) per small grower. In productive orchards, yields of 3.1 tons per hectare were reported in Afghanistan, compared to Pakistan's 9-12 tons per hectare, Turkey's 25-35 tons per hectare, and South Africa's 50-60 tons per hectare. The growth of a competitive commercial citrus industry may be hindered by the lack of economies of scale and efficient orchard management techniques. Small growers manage 370 hectares of citrus orchards across 1,175 blocks, of which 536 are currently productive, yielding approximately 1,400 tons of sour oranges. Of this yield, 92% (1,300 tons) reaches the market, generating around 28 million AFN, or about 2.6 AFN per kilogram. Sour orange orchards occupy 212 hectares of productive land, with an additional 90 hectares expected to become productive over the next seven years. The market for sour oranges is nearing saturation, and traders and wholesalers anticipate that increased production will exacerbate market pressures. In 2013, certified planting covered 31 hectares, primarily sweet orange (14.6 hectares) and lemon (14.4 hectares). However, only 2.5 hectares are currently productive. According to growers, 72% of orchards have been established through development programs such as the National Horticulture and Livestock Program (NHLP). One of the main challenges is finding innovative ways to involve small growers in commercial citrus production. NVDA's 2,914 hectares of citrus-growing land includes 501 hectares under cultivation, which yielded 375 tons in the 2014 season. However, only 14 tons reached the market, generating an average farm gate profit of 18.02 AFN per kilogram. The decline in production is attributed to many productive areas being in insecure locations, limiting market access (Booyens et al., 2015).

Regarding protection measures, fruit fly management aims to minimize yield loss and improve the quality of fruits and vegetables by eradicating fruit fly larvae. Various approaches to fruit fly management are implemented globally, depending on available economic resources. Given the complexity of fruit fly species and their coexistence within segmented fruit and vegetable production systems, it is crucial to employ a comprehensive, integrated pest management strategy that combines all feasible methods (Ekesi et al., 2007). Before devising a management strategy, understanding the ecology and behavior of fruit flies is essential (Ansari et al., 2012). In theory, fruit fly management techniques in horticultural crops primarily involve field sanitation to hinder life cycle progression, mating disruption, the use of food lures, and the application of synthetic pesticides, botanicals, bio-rational

pesticides, cultural practices, exclusion methods, and post-harvest treatments, among others. These strategies vary in effectiveness and are applied to different extents by farmers. Shapkota et al. (2009) examined the fruit fly management techniques employed by farmers and found that these encompassed indigenous methods (70%), chemical approaches (32%), mechanical solutions (80%), and combinations of two or more methods (60%).

The study has the following objectives:

1. Assess farmers' perceptions of the expertise of extension field staff in fruit fly protection measures for achieving self-sufficiency in sweet oranges.
2. Identify control measures for the fruit fly and the proper timing for trap installation to improve self-sufficiency in citrus fruits.
3. Provide policy recommendations for future decision-making.

Methods and Materials

Fruit flies puncture and sting the skin of fruit before harvest by laying eggs inside. After hatching, the larvae feed on the pulp, which affects the fruit's ripening and causes them to drop before maturity—a serious hurdle in achieving self-sufficiency in sweet oranges. This study assessed farmers' perceptions of the self-sufficiency strategies of extension workers in protecting citrus fruits from fruit flies in Nangarhar Province, Afghanistan. Nangarhar comprises 22 districts, with Bati Kot selected purposively for its favorable soil and climate for sweet orange cultivation. Additionally, the researcher is from this district, making data collection easier by understanding local customs and traditions. Five villages (Ghazeabad, Shab Diyani, Anbar Khana, Barekab, and Lowartay) were selected for their citrus orchards. From a list provided by the Agriculture Extension Department, 60% of respondents were chosen through proportional allocation, totaling 120 respondents from an original 200 for data collection. For primary data collection, a well-prepared and examined interview schedule was used, developed in English but conducted in respondents' native languages for their comfort and ease. Various government, semi-government, public, and unpublished sources were used for secondary data. Data was analyzed using the Statistical Package for Social Sciences (SPSS v.20) to interpret the findings. The Chi-square test was applied to assess associations between variables, with results presented using tables, graphs, standard deviation, means, and frequencies.

Results and Discussion

Demographic Details of the Citrus Growers

Age, literacy, and family size can significantly impact citrus production. Older growers may have more experience and knowledge about citrus cultivation, leading to better crop management and higher yields. However, they may also resist adopting modern practices, hindering productivity. Age-related physical limitations can further affect their ability to work in orchards. Education enhances farmers' ability to access Information on best practices, pest control, and market trends, thereby increasing income levels.

Conversely, limited education can reduce the ability to learn and apply new techniques, negatively impacting productivity. Household members contribute labor, share responsibilities, and assist with all farming activities, from preparation to marketing, boosting overall farm productivity and aiding citrus self-sufficiency. Demographic Information is presented in Figures 1, 2, and 3.

Citrus Growers' Age

Studies suggest that people in their early 20s are more receptive to innovative ideas. Research has shown a strong correlation between age and innovation adoption (Afsar and Idrees, 2019). Figure 1 shows that most citrus growers in the study area (32%) are aged 40–50, with 23% aged 20–30. Age influences modern farming practices, with younger farmers adopting new technologies more readily than older ones, who may take longer to assimilate them (Agwu et al., 2008). Our findings align with those of Okwu et al. (2007), as most growers in the area, aged 40–50, were less inclined to adopt modern practices.

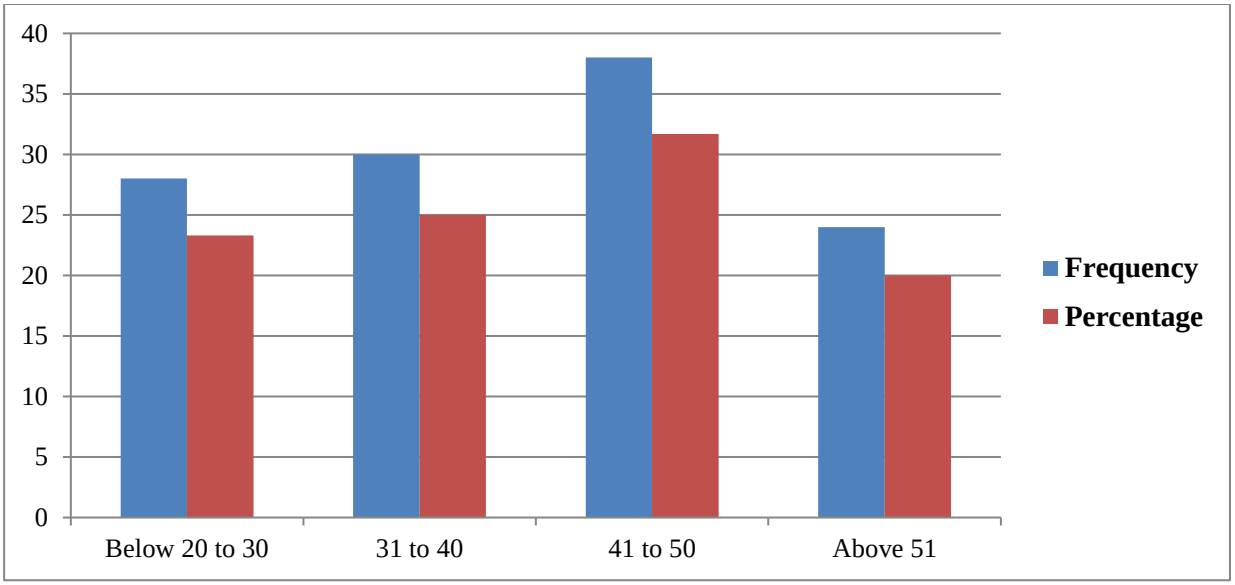

Fig 1: Age of the Citrus Growers

Literacy Status of the Citrus Growers

Education is a pillar of national development. In industrialized nations, over 90% of people are literate. Illiterate farmers are less likely to accept new technologies, as convincing them is more challenging than literate farmers, who adopt modern methods more readily (Sanaullah et al., 2020). Literacy plays a crucial role in adopting the latest farming technologies, influencing the willingness to adopt better farming techniques. Education enables individuals to stay informed on environmental and agricultural advancements, promoting scientific approaches to farming (Aziz et al., 2018). Figure 2 reveals that 55% of citrus growers in the study area were illiterate, with 45% literate. Among the literate, 32% had primary to middle education, 8.3% completed matric, and 4.2% had intermediate education. These findings align with Doudiyal (2006), who reported a high illiteracy rate (97%) in his study area.

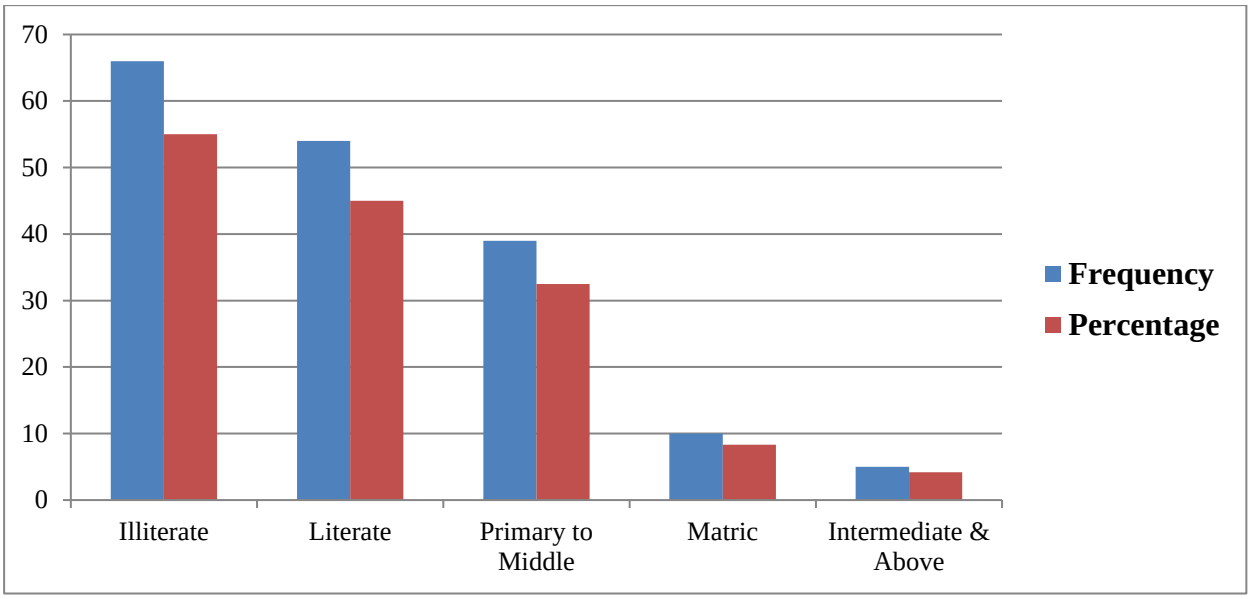

Fig 2: Citrus Growers' Distribution as per their literacy level

Household Size of the Citrus Growers

With the world's population growing rapidly, food and necessities may be scarce. Population control is necessary to address these issues, and household size is crucial in the adoption process (Sanaullah et al., 2020). Figure 3 shows that 29.2% of citrus growers have household sizes of 1–8 members, 43.3% have 12 or more members, and 27.5% have 9–12 members. Larger households, with ample labor available, typically do not need to hire labor for various field activities. Our results align with Ayat (2014), who reported that 38.8% of households had 11–20 members, similar to our findings that most citrus growers have more than 12 members.

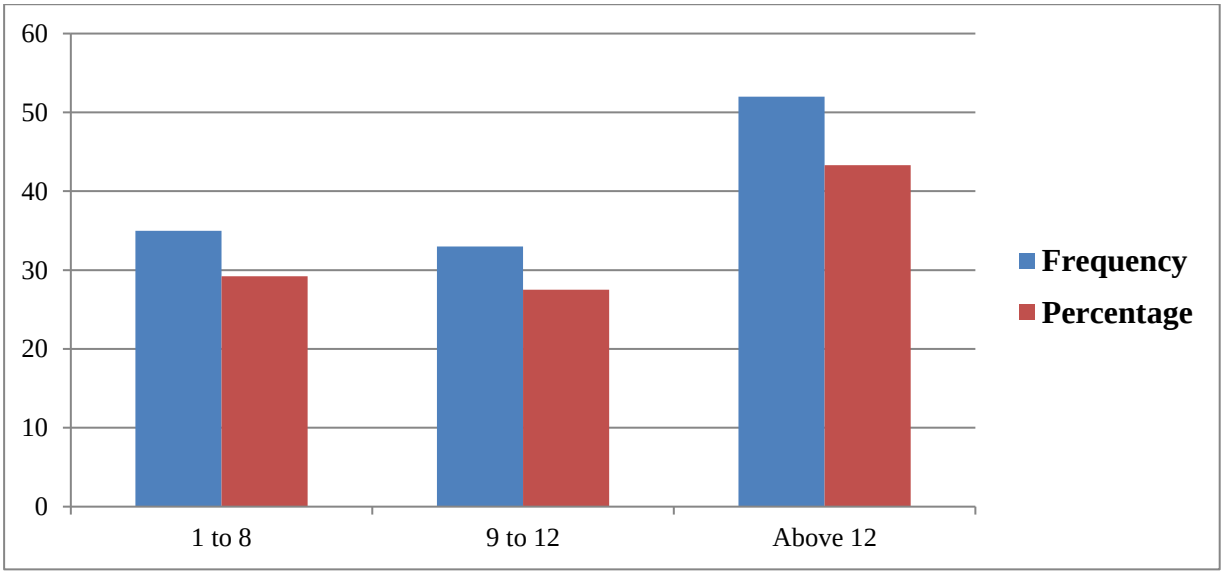

Figure 3: Household Size of the Citrus Growers

The Department of Agriculture Extension supports the farming community in improving crop and fruit yield to enhance socio-economic conditions within their community. Farmers may also contact extension workers by phone to report their concerns and receive prompt advice when field visits are limited due to workers' busy office schedules. Table 1 presents findings

on citrus growers' contact with extension department staff for advice on inputs, pest and disease Control, and weed control. It reveals that most citrus growers (68%) contact the extension department by telephone, while 32% do not. Those who contacted the department were also asked to specify the issues that led them to seek assistance. Among these, 33% sought advice on pest and disease control, 7% inquired about input usage, 17% sought weed control measures, and 10% requested guidance on improving citrus production. This data shows that most citrus growers are interested in protection measures for their crops and trust the extension department's recommendations, which could improve their standard of living through scientifically based advice that enhances citrus production and supports self-sufficiency.

Table 1. Contact Ratio of Citrus growers with Agriculture Extension Department for various concerns

Villages	Contact Ratio of Citrus growers with Agriculture Extension Department							Total
	Yes	No	Total	Various concerns of the Citrus Growers				
				Field Practices	ManagementInputs	Pest/diseases	Measure of Weed Control	
Ghazi Abad	26(21.7)	4(3.3)	30	4(3.3)	1(0.8)	15(12.5)	6(5)	26
Shab Diyani	14(11.7)	10(8.3)	24	3(2.5)	0(0)	6(5)	5(4.2)	14
Lowarty	16(13.3)	8(6.7)	24	3(2.5)	3(2.5)	7(5.8)	3(2.5)	16
Anbar Khana	12(10)	9(7.5)	21	0(0)	2(1.7)	6(5)	4(3.3)	12
Barekab	13(10.8)	8(6.7)	21	2(1.7)	3(2.5)	5(4.2)	3(2.5)	10
Total	81(68)	39(32)	120	12(10)	9(7)	39(33)	21(17)	81

Source: Field Survey data 2022-23

Note: Parentheses values show the percentages

Knowledge of Citrus Growers about Citrus Fruit Flies

Extension workers are essential in combating fruit fly infestations, providing vital support to citrus growers by spreading knowledge about fruit flies and effective control strategies. They educate farmers on the biology and behavior of fruit flies, guide them in setting up monitoring systems, and promote integrated pest management (IPM) approaches that use various control methods. Extension workers may guide responsible pesticide use, encourage cultural practices that reduce fruit fly habitats, and introduce biological control measures. Although fruit flies can aid citrus pollination, they can also damage citrus fruit by laying eggs inside, leading to spoilage and yield reduction. The study found that 63% of citrus growers were unaware of fruit flies in their orchards, while 37% had some knowledge of fruit flies, mainly due to the extension department's awareness efforts, as shown in Table 2. These findings suggest that fruit flies are not a primary concern for most citrus growers, and they do not actively seek advice from the extension department. Meanwhile, some growers keen on improving production levels are more inclined to learn about environmentally friendly and effective fruit fly control methods from the extension department.

Table 2. Citrus Growers' Distribution regarding the Information of Fruit Flies

Villages	Citrus Growers' Distribution Regarding the Information of Fruit Flies		Total
	Yes	No	
Ghazi Abad	12(10)	18(15)	30
Shab Diyani	10(8.3)	14(11.7)	24
Lowarty	5(4.2)	19(15.8)	24
Anbar Khana	6(5)	15(12.5)	21
Barekab	11(9.2)	10(8.3)	21
Total	44(37)	76(63)	120

Source: Field Survey data 2022-23

Note: Parentheses values showing the percentages

Fruit Fly Management Techniques Employed by Citrus Growers

The effective management of fruit flies in citrus orchards is essential for ensuring healthy yields and sustaining the citrus industry for self-sufficiency in the country. Citrus growers employ a multifaceted approach that integrates various techniques, including monitoring, cultural practices, biological control, chemical interventions, and exclusion netting. By adopting a combination of these strategies and tailoring them to specific orchard conditions, growers can minimize fruit fly damage by maintaining the vitality of their citrus fruits. Monitoring fruit flies is crucial in citrus production, as fruit flies must be identified in their orchards. Fruit flies can be controlled economically by integrated pest management (IPM) strategies with traps, bait stations, and targeted pesticide applications. Self-sufficiency is the only possible way to protect citrus from damage by fruit flies by ensuring the harvest is successful. Most of the citrus growers (51%) used pesticides for controlling the fruit fly, 22% controlled the fruit fly by burying the infected fruits in the soil, and 18% used the pheromone traps for fruit fly Control, per common practice in Afghanistan. Only 10% were involved in cultural practices for controlling the fruit flies, while none was found in IPM in the study area. However, more studies need to be conducted to confirm these scientific controls through pesticides of fruit flies by not compromising the taste and quality of citrus fruits used for various home-use products. IPM may be encouraged for environmentally friendly and less expensive purposes

Table 3. Fruit fly Management Techniques of the Citrus Growers

Villages	Techniques &Methods of Fruit Fly Control				Total
	Use of Pesticides	Buried the Infected Fruits	Pheromone Traps	Cultural Control	
Ghazi Abad	14(11.7)	6(5.1)	6(5.0)	4(3.3)	30(25)
Shab Diyani	15(12.5)	4(3.3)	4(3.3)	1(0.8)	24(20)
Lowarty	16(13.4)	2(1.7)	5(4.2)	1(0.8)	24(20)
Anbar Khana	4(3.4)	9(7.5)	2(1.7)	6(5)	21(17.5)
Barekab	12(10)	5(4.2)	4(3.3)	0(0)	21(17.5)
Total	61(51)	26(22)	21(17)	12(10)	120(100)

Source: Field Survey data 2022-23

Note: Parentheses values showing the percentages

. Do it by yourself (DIY) was told by none of the extension workers by mixing a quarter cup of either apple cider vinegar or white vinegar with a few drops of dish soap. The idea is that the irresistible vinegar attracts the fruit flies while the soap breaks the vinegar's surface tension and drowns them. The data regarding fruit flies' management techniques as perceived by citrus growers are depicted in Table 3 above.

Knowledge of Suitable Months for Fruit Fly Trap Installation

Knowing the optimal months for installing fruit fly traps is essential for effective pest management. This information allows farmers to align their pest control efforts with the fruit fly's reproductive cycle, ensuring that traps are in place when these pests are most active, preventing infestations, and minimizing crop damage. Understanding the installation month helps farmers plan and coordinate pest control activities, maximizing resources and increasing the traps' efficiency. This knowledge empowers citrus growers to take a proactive approach to pest control, leading to healthier plants and better yields. Thus, understanding the ideal month for trap installation is critical to sustainable agricultural practices. Citrus growers must be aware of fruit flies' life cycle to protect their crops, applying insecticides or using physical barriers like nets at the appropriate time. If pheromone traps are installed between April and September, male flies can be trapped, and females lay sterile eggs, reducing the population. A trap can be prepared using 5 drops each of methyl eugenol and Malathion 50% E.C. on a cotton piece, placed throughout the orchard in spring to control emerging fruit flies. The study found that 83% of growers did not know the appropriate months for trap installation, and only 17% learned to install traps in April for catching males and encouraging sterile egg-laying by females. This reveals a lack of extension department engagement in educating citrus growers on proper trap timing. The department could support the goal of self-sufficiency by improving fruit fly control, increasing citrus production, and enhancing growers' socio-economic status. Table 4 provides data on the suitable months for fruit fly trap installation.

Table 4. Information about Suitable Month of Fruit Fly Traps' Installation

Villages	Information on Fruit Fly Traps Installation Months			Total
	Yes	No	If Yes, Mention the month April	
Ghazi Abad	6(5)	24(20)	6(5)	30
Shab Diyani	4(3.3)	20(17)	4(3)	24
Lowarty	5(4)	19(15.8)	5(4.2)	24
Anbar Khana	2(1.7)	19(15.8)	2(1.7)	21
Barekab	4(3.3)	17(14.2)	4(3.3)	21
Total	21(17)	99(83)	21(17)	120

Source: Field Survey data 2022-2023

Note: Parentheses values showing the percentages

Citrus Grower's Perception of the Information of the Attacking Months of Fruit Flies

Citrus growers are seriously thinking about the time/ month of fruit fly attack due to the significant damage to citrus trees, causing reduced yields and fruit quality. The peak season for citrus fruit fly attacks varies depending on the region but generally occurs during the warmer months when temperatures are between 20-30 degrees Celsius. In many areas, June is a critical time for citrus growers to monitor their crops and take action to control fruit fly infestations. These fruit flies can be a problem throughout the year but are common specifically during late summer/ fall because they are attracted to ripen of fermenting fruits and vegetables. Their life cycle takes 28-34 days in summer and 60-115 days in winter. Researchers identified that 68% of citrus growers in the research area did not know about fruit fly attacking months, and only 32 % knew the fruit fly attack months, where 74% among the informed citrus growers told the month of June and 26% among informed said the month of May. This shows the concerns of citrus growers regarding the attack of fruit flies on their citrus orchards. Still, negligence is reported and revealed on the part of extension workers as per the need of the day, where most were not informed about the attacking months of fruit flies. The extension department may educate and advise citrus growers about active months of fruit fly attacks to minimize the losses of citrus growers and bring self-sufficiency in citrus fruit as per their advanced and scientific training in the field. Data presented in Table 5 shows Information about the attacking months of fruit flies.

Table 5. Citrus Growers' Distribution regarding the Information of the Attacking Months of Fruit Flies

Villages	Information about Fruit fly Attack Months				Total
	Yes	No	If Yes, Mention the Month		
			May	June	
Ghazi Abad	11(9.2)	19(15.7)	2(5.2)	9 (23.7)	11(28.94)
Shab Diyani	6(5.1)	18(15)	3(7.8)	3 (7.8)	6 (15.79)
Lowarty	6(5.1)	18(15)	2(5.2)	4 (10.6)	6 (15.79)
Anbar Khana	6(5.1)	15(12.4)	1(2.6)	5 (13.4)	6 (15.79)
Barekab	9(7.5)	12(10)	2(5.2)	7 (18.5)	9 (23.68)
Total	38(32)	82(68)	10(26)	28(74)	38(100)

Source: Field Survey data 2022-2023

Note: Parentheses values showing the percentages

Know-how about Removal of Infected Drop Fruits from Citrus Orchards. Disposing of the appropriately infected dropped-down fruits due to disease is essential ests to prevent spreading of diseases and pests in fruit trees. Infected drop fruits can attract insects and rodents, which take and transmit the diseases to healthy trees. It is recommended that infected drop fruits be removed from the ground and placed in a sealed bag or container to control the spread to other areas of the orchard, garden, and trees. Moreover, cleaning the area around the infected drop fruits to prevent any remaining debris or contaminated soil from becoming a breeding ground for pests and disease is also beneficial. Proper disposal of infected drop fruits is an essential step in maintaining the health and productivity of the citrus fruit trees. Most citrus growers (68%) know about discarding the infected dropped fruit, while

32% of citrus growers did not know about the dispose-off of the infected dropped fruits. About 25% of citrus growers were throwing away these infected dropped fruits, while 22% buried the infected dropped fruits, and 14% fed them to their animals. This shows a very good sign of taking an interest in the infected dropped fruits to control the infected fruits' damage. This shows their sensitivity and concern in sustaining citrus production for better exchange earnings by the citrus growers for bringing self-sufficiency to Afghanistan in the citrus fruits. The data regarding the know-how of citrus growers about the removal of various measures of the dropped fruits from their orchards is revealed in Table 6.

Table 6. Measures of the Citrus Growers about the Removal of Infected Dropped Fruits

Villages	Measures of the Citrus Growers about the removal of infected dropped fruits.							Total
	Yes	No	Total	If Yes				
				Throwing away	Buried infected fruits	the Feed Animal	to No Action	
Ghazi Abad	22(18.3)	8(6.7)	30	10(8.3)	7(5.8)	3(2.5)	2(1.7)	22
Shab Diyani	20(16.7)	4(3.3)	24	9(7.5)	3(2.5)	5(4.2)	3(2.5)	20
Lowarty	17(14.2)	7(5.8)	24	5(4.2)	7(5.8)	3(2.5)	2(1.7)	17
Anbar Khana	14(11.7)	7(5.8)	21	3(2.5)	6(5)	4(3.3)	1(0.8)	14
Barekab	9(7.5)	12(10)	21	3(2.5)	3(2.5)	2(1.7)	1(0.8)	9
Total	82(68)	38(32)	120	30(25)	26(22)	17(14)	9(8)	82

Source: Field Survey data 2022-2023

Note: Parentheses values showing the percentages

Citrus Growers' Perception of the Skills of Extension Workers in Protection Measures Regarding Control of Fruit flies in the Citrus Orchards of Afghanistan. Fruit flies mainly affect production and thus affect farmers' income from every crop and fruit, as per the experience of many studies in the past, which need proper and special attention for particular farming communities and the department built for caring for the same specific tasks by the government. Controlling fruit flies in citrus orchards is essential as it negatively influences the productivity of citrus fruits. Extension agents are responsible for adequately training the farmers in controlling citrus fruit flies to boost their economy and improve their socio-economic condition. Data presented in Table 7 shows citrus growers' perception of extension staff's abilities to teach farmers how to manage fruit flies, divided into three categories: good, acceptable, and poor. The results depict that a maximum (46%) of citrus growers placed them on average.

In comparison, 39% of citrus growers placed them in the poor category and said that their knowledge about fruit fly control was inadequate, and 15% of citrus growers said that extension agents did an excellent job and placed them in the good category for instructing them to control fruit fly in the citrus orchards. This shows that only 15% of growers marked them as good, showing that extension workers of the extension department cannot revolutionize bringing change in the citrus growing community. About 85% of citrus growers

need to be trained in improving their skills in the control of fruit flies as citrus growers were not satisfied with their abilities, placing them in average and poor categories.

Table 7. Perception of Citrus Growers regarding Skills of Extension Workers in protection measures regarding Control of Fruit Flies in Citrus Orchards

Villages	Skills of Extension Workers in Educating Farmers about Fruit Fly Control			Total
	Good	Average	Poor	
Ghazi Abad	4(3.3)	15(12.5)	11(9.2)	30(25)
Shab Diyani	3(2.5)	13(10.8)	8(6.7)	24(20)
Lowarty	5(4.2)	6(5)	13(10.8)	24(20)
Anbar Khana	2(1.7)	14(11.7)	5(4.2)	21(17.5)
Barekab	4(3.3)	7(5.8)	10(8.3)	21(17.5)
Total	18(15)	55(46)	47(39)	120(100)

Source: Field Survey data 2022-2023

Note: Parentheses values showing the percentages

Farmers' Perception Regarding the Skills of Extension Workers in Overall Plant Protection Measures. Extension workers in citrus cultivation may possess essential plant protection skills for every crop and plant. The Holy Quran also mentions flies, ants, bees, mosquitoes, locusts, termites, and moths. They may be trained to identify and mitigate threats to citrus plants, including pests, diseases, and environmental stressors. These professionals are proficient in implementing integrated pest management strategies involving biological controls, cultural practices, and targeted chemical interventions. They also excel in monitoring and diagnosing plant health issues, enabling them to provide timely and practical recommendations to citrus growers.

Table 8. Citrus Growers' Perception of Extension Workers Skills in Overall Plant Protection Measures of Citrus

Plant Protection Skills	1	2	3	4	5	Mean	S.D	Ranks
Symptoms of major insects/ pest identification & infestation of causes of disease to citrus plants	10(8.3)	15(12.5)	41(34.2)	34(28.3)	20(16.7)	3.325	1.146	I
Selecting the economical methods of Pest control	18(15)	21(17.5)	36(30)	30(25)	15(12.5)	3.025	1.240	II
Knowledge of diversified Environmental effects of pesticide	25(20.8)	29(24.2)	34(28.3)	22(18.3)	10(8.3)	2.692	1.228	III
Identification of various life stages of citrus insects	40(33.3)	28(23.3)	21(17.5)	20(16.7)	11(9.2)	2.450	1.346	IV
Biological control knowledge of pests	45(37.5)	33(27.5)	26(21.7)	10(8.3)	6(5)	2.158	1.167	V

Scale: 1= Very Low 2= Low 3= Medium 4= High 5= Very High S.D= Standard Deviation

Additionally, extension workers play a crucial role in disseminating knowledge about sustainable and eco-friendly plant protection methods, contributing to citrus orchards' overall health and productivity. It is also important to know about pest, disease, and insect identification, as Rafea (2010) suggested. Table 8 shows the ranking of plant protection measures of agricultural extension workers' skills per citrus growers' point of view based on mean (M) and standard deviation (S.D.). Symptoms of major insects/ pest identification and infestation of disease caused by citrus plants were ranked on top with the highest mean value of 3.325 and SD of 1.146. Biological control knowledge of pests was revealed at the lowest rank, with the lowest mean value of 2.158 and SD 1.167. Our results are almost similar to that of Saddam (2021), who revealed that symptoms identification of insect/ pest infestation and the cause of disease was ranked 2nd by the tomato growers in the study area of District Peshawar, Khyber Pakhtunkhwa-Pakistan.

Association between Average Citrus Yield & Extension Workers' Overall Skills in Plant Protection Measures. The chi-square test was used to find the association between the average yields of citrus and the skills of extension workers in overall plant protection measures in the study area. Findings in Table 9 showed a highly significant association (p=0.000) between the average yield of citrus and the skills of extension workers in overall plant protection measures. The results indicated that farmers who ranked extension workers' skills in plant protection measures as medium, high & very high obtained high yields compared to other growers in the study area.

Table 9. Association between Average Yield of Citrus and Skills of Extension Workers in Plant Protection Measures

Average yield of citrus (Kg/Acre)	Skills of Extension Worker in Plant Protection Measures					Total
	Very Low	Low	Medium	High	Very High	
Up to 3000	12(10)	6(5.0)	8(6.7)	3(2.5)	1(0.8)	30
3001 to 6000	9(7.5)	7(5.8)	25(20.8)	12(10)	2(1.7)	55
6001 to 8000	1(0.8)	3(2.5)	7(5.8)	8(6.7)	2(1.7)	21
Above 8000	0(0)	1(0.8)	2(1.7)	6(5)	5(4.2)	14
Total	22(18.3)	17(14.2)	42(35)	29(24.2)	10(8.3)	120
	x^2 = 39.123		P-value= 0.000***			

Data Source: Calculated by Author

Association between Age of the Citrus Growers and the Average Yield of Citrus in Afghanistan. The association between Age and average yield of citrus in the study area is presented in Table 10. A Chi-square test was employed to determine this relationship. The study results reveal a highly significant association (p=000) between Age and average yield of citrus. Consequently, the research findings suggest that Age is crucial in citrus production. Table 10 provides the data concerning the association between Age and average yield of citrus.

Table 10. Association between the Age of the respondents and the average yield of citrus

Average yield of citrus (Kg/Acre)	Age of the respondents (in years)				
	Below 20 to 30	31 to 40	41 to 50	Above 51	Total

Up to 3000	22(18.3)	8(6.7)	0(0)	0(0)	30
3001-6000	6(5)	19(15.8)	25(20.8)	5(4.2)	55
6001-8000	0(0)	2(1.7)	12(10)	7(5.8)	21
Above 8000	0(0)	1(0.8)	1(0.8)	12(10)	14
Total	28(23.3)	30(25)	38(31.7)	24(20)	120
	x^2 =110.916		P=0.000***		

Data source: Calculated by Author

Conclusions

Extension workers educated the citrus growers on plant protection measures for fruit fly control. Still, a limited number of citrus growers knew about April's advice for trap installation as per the expected attack in May and June in the study area. Citrus growers used a variety of plant protection measures to control fruit flies, like pheromone traps, burying the infected fruits, and cultural and chemical control methods with no advice from IPM. Most citrus growers ranked extension workers' skills in controlling fruit flies as average, followed by poor. Agricultural extension personnel did not pay serious attention to solving farmers' difficulties with fruit flies, causing major damage to citrus growers' economies and thus hindering citrus self-sufficiency. Farmer's perception of extension workers' expertise in different aspects of citrus production as per top rank were the symptoms of major insects/pest identification and infestation of causes of diseases, effective use of farmyard manure, ability in the fruit fly, forecasting maturity and yield and knowledge of post-harvest losses. A highly significant association existed between average yields and extension workers' skills in plant protection measures. Similarly, Age had a highly significant association with the average yield of citrus.

Recommendations

Based on the conclusions of the study, the following recommendations were made:

- Extension workers may regularly visit citrus producers' orchards, especially in April, to advise trap installation to control the fruit fly attack and provide basic knowledge about fruit flies for better citrus production and related problems. This will strengthen their relationship, consequently resulting in improved citrus orchard development.
- The Agriculture Extension Department may distribute citrus varieties and traps free of cost to control the fruit flies in their citrus orchards. More emphasis should be placed on IPM due to its economical and friendly nature.
- Citrus is a high-cash crop, so youth should be trained in controlling fruit flies, efficiently motivated, and diverted to play an active role in the self-sufficiency of their beautiful country. More formal training regarding different aspects of citrus cultivation and various methods for Controlling fruit flies may be arranged by the Extension Department to save citrus growers from the damages caused by fruit flies on large scales.
- Interest-free credit facilities may be provided to citrus growers at appropriate times to buy inputs such as improved varieties, fertilizers, pesticides, insecticides, and traps for fruit fly control to repair the citrus orchards damaged by war.

- Research should be conducted on citrus improved varieties to find out which variety is better for which place, and improved varieties should be given to the citrus growers to increase their production.
- The government may keep in touch with research scientists regarding the challenges citrus growers face, and timely agricultural input should be provided to boost citrus production.
- As highlighted in the study, agriculture extension workers must be upgraded and improved in weak areas by providing in-service training opportunities and refresher courses nationally and internationally.

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