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# Assessment of Farmers' Knowledge, Attitudes, and Practices Pertinent to Use of Insecticides and Biological Control Agents in Agroecosystem of Narowal, Pakistan

Warda Mustfa[1,*], Nazia Ehsan[2], Muhammad Umar Ijaz[3] and Muhammad Ahsan Khan[4]

[1,2,3]Department of Zoology, Wildlife and Fisheries, University of Agriculture, Faisalabad, Pakistan; [4]Department of Entomology, University of Agriculture, Faisalabad, Pakistan.
[*]Corresponding author's e-mail: wardamustfa18@gmail.com

The widespread and unregulated use of insecticides in Pakistan's agriculture harms the environment, human health and agriculture by causing pollution, biodiversity loss, pest resistance, health risks, and economic burdens. This study aimed to evaluate farmers' knowledge, attitudes, and practices regarding insecticide use and biological control agents for pest management in District Narowal, Punjab, Pakistan. A survey was conducted across three tehsils Narowal, Zafarwal, and Shakargarh between October 2022 and February 2023, utilizing a questionnaire to collect data from 300 farmers, 97.6% of whom were male. Findings indicated that most farmers lacked an understanding of insecticide, modes of action and chemical composition, were unfamiliar with biological control methods, and had not received guidance from agricultural extension officers. Additionally, many farmers did not follow safe disposal practices for empty insecticide containers. Statistical analysis revealed that low educational levels and limited awareness contribute to decline of beneficial insects, pest resistance, secondary pest outbreaks, health risks, and environmental pollution. Present study underscores the urgent need for public awareness initiatives and the promotion of integrated pest management (IPM) to support sustainable agricultural practices in this region
**Keywords:** Crops, imidacloprid, irrigation methods, hazards, agricultural products

## INTRODUCTION

Agriculture is the second-largest employment sector globally (ILO, 2010). Pakistan, is predominantly an agriculture country, the agricultural sector forms backbone of the economy. Globally, approximately 1.8 billion individuals rely on insecticides to safeguard crops from pest damage and improve yields. In Pakistan, 42.5% of rural population is participating in agriculture. In recent decades, agricultural production has surged due to increased reliance on inorganic fertilizers and external inputs such as insecticides, which have significantly enhanced the yield of food. Insecticides utilization has been increased in boosting crop productivity. However, growing concerns have emerged regarding the excessive use of insecticides, causing toxicity for alive beings, water soil, air and causing harmful environmental and health impacts (Anwar, 2017).

In Pakistan, the most frequently used insecticides are organophosphates, neonicotinoids, carbamates, and pyrethroids. The various reports showed that Pakistan used 108 types of insecticides, 39 herbicides, 6 rodenticides, and 5 acaricides against various crop pests (Anwar *et al.*, 2011). In developing countries like Pakistan, insecticide use per hectare has escalated by 9% (Abbas *et al*., 2014). Agricultural workers and farmers are routinely exposed to numerous insecticides, that have detrimental health effects (Hvistendahl, 2013). Farmers, often unaware about the negative effects of insecticide overuse, heavily depend on these chemicals against pests and protect their crops. It not only contributes to health hazards and environmental pollution and but also leads to decline in the population of beneficial insects and the development of pest resistance (Abdollahzadeh *et al*., 2016).

Punjab Province cultivates various crops, including rice, wheat, cotton, sugarcane, vegetables, and fruits. Sap-sucking insects pose a major threat to these crops throughout their developmental stages. Insecticides remain the predominant means of pest control in this region (Boatman *et al*., 2007). Farmers lack adequate awareness about the chemical properties of insecticides, a gap further exacerbated by insufficient support from agricultural extension services (Chaplin-Kramer *et al*., 2011; Bommarco *et al*., 2013). Factors such as limited education, inadequate knowledge, and unintentional application errors, including careless, insecticide handling, expose farmers to serious health risks (Damalas *et al*., 2006). Concerns about insecticide-related

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health hazards are increasingly prevalent in developing countries due to low educational levels and poor working conditions (Gibbs *et al*., 2009). Farmers are the end-users of insecticides, their knowledge about the proper use and disposal of these chemicals is important in reducing environmental pollution and health risks, not only for themselves but also for the community (Yang *et al*., 2014). Improper disposal of empty containers that contain surplus quantity of pesticides leads to the environmental pollution (Bakhtawer and Sumera, 2021).

Biological control methods, which use natural predators, present a cost-efficient and eco- friendly alternative to chemical insecticides. It involves using one organism to reduce the population of another, provides an effective and sustainable alternative to chemical pest control (Losey and Vaughan, 2006; Bale, 2011; Bommarco *et al*., 2013). This approach not just reduce pest outbreaks but also generates positive economic and ecological effects, such as biodiversity conservation and reduced health risks (Gibbs *et al*., 2009; Boatman *et al*., 2007; Naranjo *et al*., 2015; Sarwar, 2015; Isenring, 2010). Despite its promotion in recent years, biological control has seen slow adoption due to various challenges (Hajek and Eilenberg, 2018). Social surveys on public perceptions of biological control have been limited (Rawluk and Saunders, 2019).

For sustainable agriculture, it is essential to reduce insecticide reliance and explore alternative pest management strategies. Public awareness campaigns play a pivotal role in educating farmers about sustainable practices. Integrating chemical and biological control measures into a comprehensive Integrated Pest Management (IPM) system is key to long-term sustainability, although such integration has very often implemented (Cock *et al*., 2010).

Considering all the factors, present survey was designed to assess farmers' knowledge, attitudes, and practices toward insecticide use, including their risks, health symptoms, use of protective equipment, and alternative pest control methods. The objective of these findings is to support the agricultural sector in developing effective farmer education programs and integrated pest management strategies are used to ensure food security and promote sustainable agriculture.

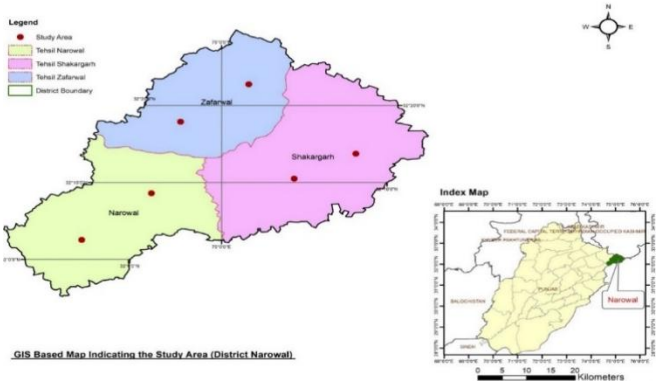
## MATERIALS AND METHODS

***Study area*:** This study was conducted in District Narowal, covering an area of approximately 2,337 square kilometers and located within Pakistan's sub-humid climatic zone. Six sites were randomly selected from district Narowal and its tehsils Shakargarh, and Zafarwal in Punjab, Pakistan. The sites were selected due to operational convenience and this region was chosen for its agricultural significance, due to water availability and favorable climatic conditions that support the cultivation of different crops, such as wheat, rice, vegetables and fruits. In this area, farmers frequently use chemical insecticides to safe their crops from pest infestations. In Table 1, demographic data for the study area was sourced from the Pakistan Bureau of Statistics (2017).

**Table 1. Demographic Profile of the Study sites.**

| District | Tehsils | Area (Sq. km) | Population | Rural (%) | Urban (%) |
|---|---|---|---|---|---|
| Narowal | Narowal, Punjab | 2337 | 1,707,575 | 82.4 | 17.6 |
| | Shakargarh, Punjab | 1272 | 674,346 | 89.3 | 10.7 |
| | Zafarwal, Punjab | 760 | 410,306 | 93.6 | 6.4 |

Study area of district narowal, its tehsils along with with their population residing in rural and urban sites.




**Map generated by (GIS-Arc)**

**Figure 1. Geographic Information System (GIS) based map delineating the study area of District Narowal and its tehsils, Shakargarh and Zafarwal showing the locations of survey sites for questionnaire.**

This map (Fig.1) highlights the three tehsils: Narowal indicated in (green), Shakargarh in (Pink) and Zafarwal in (blue) color. Each tehsil contains two marked points (sites) representing the sites of survey. Questionnaire was filled by farmers from these sites and their responses were recorded

***Questionnaire design*:** A questionnaire was designed following two previous studies (Damalas *et al*., 2008; Yang *et al*., 2014) with slight modifications using close-ended questions to collect information in local languages (Urdu and Punjabi). The questionnaire was kept simple and easy to understand. With framers consent, verbal communication was used to record their answers because most farmers were illiterate. The simple questions provided insights into farmers' perceptions and knowledge of insecticides and biological control.

The questionnaire comprised five distinct sections. The first section focused on the sociodemographic characteristics of farmers such as gender, education level, farming experience and irrigation methods. The second and third sections were

pertinent to farmers' knowledge about mostly used insecticides, cultivated crops and their commonly occurring pests, farmers' rationale about insecticides use and their relevant risks. Fourth and fifth sections were related to training, attitude and practices of farmers with respect to insecticides use and their understanding for biological control methods. The questionnaire was reviewed and revised by the authors of this study.

***Interview procedure*:** The survey was executed from October 2022 to February 2023, with a total of 300 questionnaires distributed (100 per tehsil) to randomly selected farmers. It was involved visiting villages for an average of 3-4 days each, where 10-15 farmers were interviewed daily. Before conducting the interviews, the study's objectives were clearly explained to the participants. The interviews were conducted face-to-face, primarily in the afternoons when farmers were available in their fields. The interview duration ranged from 30 to 60 minutes and the questions were asked in simple language to ensure clarity. The objective was to gain insights about farmers' knowledge, attitudes, and practices regarding insecticide use and biological control methods.

***Statistical analysis*:** Summaries of the data were calculated using SPSS software (version 25), and significant differences (p-value < 0.05) between the various answers to each question were evaluated using a chi-square test.

## RESULTS

The present study achieved 100% response from a total of 300 agronomists of wheat, rice, millet, sorghum, and various vegetables.

***Demographic characteristics of Farmers*:** The demographic analysis of survey revealed a pronounced gender disparity in agricultural engagement, with a majority of male (n=293, 97.7%) and female participation in farming constituted only (n=7, 2.3%) of total sample (Fig. 2).

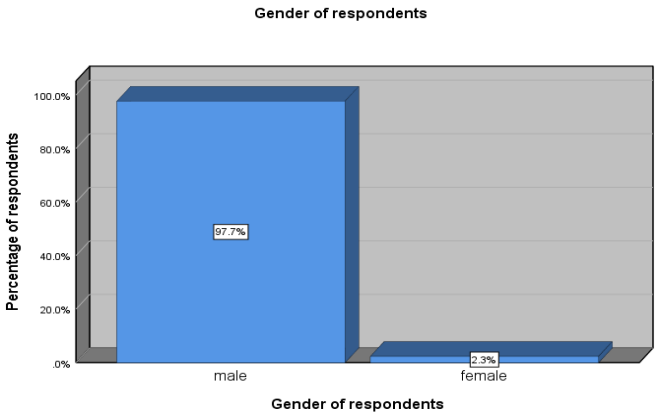



**Figure 2. Demographic analysis of survey showing a pronounced gender disparity in agricultural engagement, with male and female participation in farming during survey.**

The demographic analysis of survey revealed a pronounced gender disparity in agricultural engagement, with a majority of male (n=293, 97.7%) and female participation in farming constituted only (n=7, 2.3%) of total sample

The educational background of the farmers is an important factor, influencing their agricultural knowledge and practices. The data indicated that (n=23, 7.7%) of farmers hold secondary education whereas (n=88, 29.3%) were illiterate (Fig. 3).

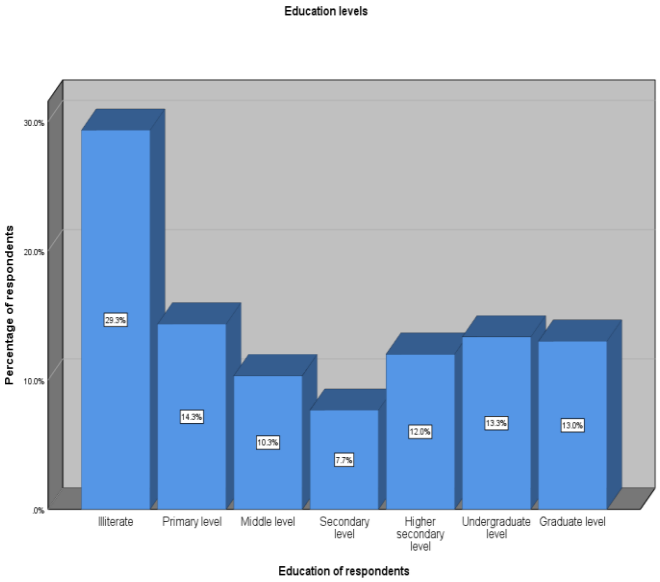



**Figure 3. Farmers' education levels, categorized into different education levels such as illiterate, primary, middle, secondary, higher secondary, undergraduate and graduate levels.**

Fig.3 shows that a significant portion of farmers, 29.3% were illiterate followed by 14.3% completed their primary level education followed by 10.3% attained middle level followed by 7.7% has secondary level education followed by 12.0% had higher secondary level and 13.3% completed undergraduate level and only 13% have completed graduate degree.

Farmers' agricultural experience varied, with the majority of (n=110, 37.0%) had 7 to 9 years' experience (Fig. 4). The largest group of farmers accounting for 37.0%, has 7-9 years of farming experience followed by 23.0%, has 4-6 years followed by 18.0% of farmers with 1-3years, followed by 15.0%, has 10-12 years while a small number of farmers (7.0%) has more than 12 years of experience, respectively

***Methods of irrigation*:** Mostly farmers (n=194, 64.67%) used tube well as irrigation method. Other irrigation practices included drip method utilized by (n=59, 19.67%), followed by the sprinkle method (n=29, 9.67%) and very few (n=18, 6%) were dependent on canal system for irrigation purpose (Fig. 5).

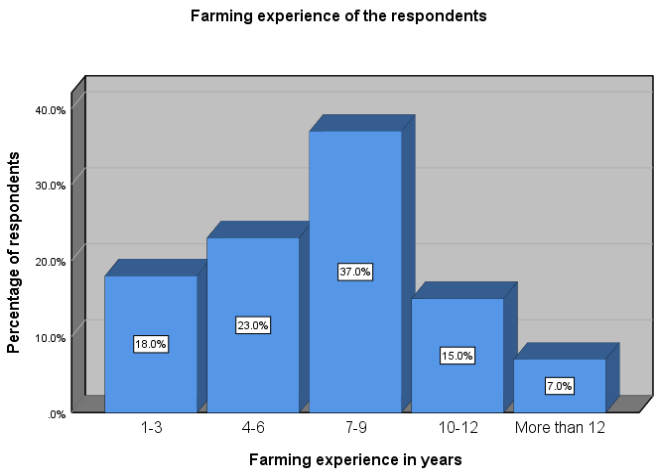



**Figure 4. Farming experience of farmer's (n=300) is shown along with their respective percentages during random sampling form farmers at six different locations from three different tehsils.**

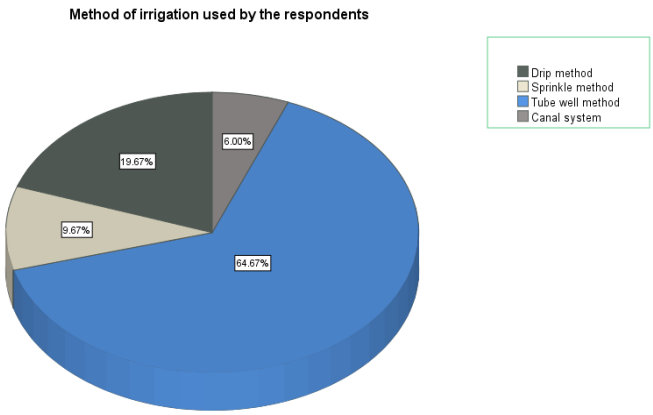



**Figure 5. Comparison of different irrigation methods such as tube well, drip, sprinkle method and canal system utilized by farmers (n=300) during survey at six sites from three tehsils.**

Framers were visited and their responses were recorded about their utilization of different irrigation methods. They responded that (64.67%) farmers used tube well method (followed by drip method (19.67%) followed by sprinkle method (9.67%) and canal system (6.00%), respectively.

***Farmers knowledge about most commonly use insecticides, cultivated crops and common pests:*** Majority of the farmers used various insecticides such as acetamiprid, imidacloprid, cypermethrin, lambda-cyhalothrin, and dimethoate, which are classified under the organophosphate and pyrethroid groups (Category II) by the World Health Organization (WHO). These chemical agents were primarily employed to manage pest infestations, which are prevalent in the study area. The pests reported in this area were Smuts (*Ustilaginaceae*), Aphids (*Aphidoidea*), Whiteflies (*Aleyrodidae*), Jassids (*Amrasca biguttula*), Mildew (*Golovinomyces orontii*), Mealybugs (*Pseudococcidae*), and Termites (*Isoptera*) (Table 2).

**Table 2. Farmer's Knowledge count (n) and frequency (%) of the responses for questions about most commonly used insecticides, cultivated crops and common pests.**

| **Knowledge of farmers** | | | | |
|---|---|---|---|---|
| | **Responses** | | **No.** | **(%)** |
| Insecticides used | Acetamiprid | Yes | 76 | 25.33 |
| | Imidacloprid | Yes | 150 | 50.00 |
| | Lambdacyhalothrin | Yes | 41 | 13.66 |
| | Dimethoate | Yes | 33 | 11.00 |
| Crops | Wheat | | 153 | 51.00 |
| | Rice | | 126 | 42.00 |
| | Sugarcane | | 3 | 1.00 |
| | Millet | | 12 | 4.00 |
| | Vegetables | | 6 | 2.00 |
| Pests | Scientific belonging | Common name | | |
| | *Ustilaginaceae* | Smuts | 30 | 10.00 |
| | *Aphidoidea* | Aphids | 147 | 49.00 |
| | *Aleyrodidae* | Whiteflies | 36 | 12.00 |
| | *Amrascabiguttula* | Jassids | 42 | 14.00 |
| | *Golovinomycesorontii* | Mildews | 30 | 10.00 |
| | *Pseudococcidae* | Mealybugs | 9 | 3.00 |
| | *Isoptera* | Termites | 6 | 2.00 |

Number of farmers (n=300), with numbers and Percentage pertinent to each question

***Knowledge of farmers about insecticides, use and their relevant risks*:** Most (n=286, 95.3%) of the farmers responded that they were knowledgeable about insecticides while a very few (n=14, 4.7%), had no knowledge. In terms of the economic burden, (n=280, 93.3%) of farmers perceived that insecticides are expensive. The environmental implications of insecticides use were not considered, with (n=270, 90.0%) of farmers answered that insecticides had no adverse effects on environment. However, (n=30, 10.0%) acknowledged the environmental risks associated with insecticide use. Furthermore, (n=191, 63.7%) reported that there are no harmful effects of insecticides on human health whereas (n=65, 21.7%) were unsure (Table 3). The results of this survey indicated that (n=209, 69.7%) of the farmers believed that insecticides do not contribute to water pollution while (n=71, 23.7%) were uncertain about this issue, and (6.7%, n=20) asserted that insecticide usage does result this. Knowledge of insecticide residues was relatively limited, with (n=140, 46.7%) claiming no knowledge of residues, (n=130, 43.3%) having no opinion, and only (n=30, 10.0%) responded about the presence of insecticides residues (Table 3).

In table 3, it is shown that a large proportion of farmers (n=178, 59.3%,) answered that insecticides were not health hazardous whereas (n=81, 27.0%) were unsure about its potential health impacts. There were (n=39, 13.0%) replied

that insecticides use lead to medical issues. The health-related complaints reported by farmers included skin allergies (n=164, 54.7%), coughing (n=62, 20.7%,), and dizziness (n=29, 9.7%).

**Table 3. Farmers' count (n) and frequency (%) of the responses for questions regarding knowledge of farmers about insecticides, use and their relevant risks.**

| Question | n (%) | $\chi^2$ | P-value |
|---|---|---|---|
| Knowledge regarding insecticides? | | | |
| Yes | 286(95.3%) | 246.61 | 0.000 |
| No | 14(4.7%) | | |
| Information source about insecticides? | | | |
| Farmers | 161(53.7%) | 56.94 | 0.000 |
| Television | 62(20.7%) | | |
| Retailers | 77(25.7%) | | |
| Insecticides have side effects on environment? | | | |
| Yes | 30(10.0%) | 192.00 | 0.000 |
| No | 270(90.0%) | | |
| Illness is related with insecticides? | | | |
| Yes | 41(13.7%) | 99.26 | 0.000 |
| No | 178(59.3%) | | |
| No idea | 81(27.0%) | | |
| Insecticides have harmful effects on human health? | | 126.42 | 0.000 |
| Yes | 44(14.7%) | | |
| No | 191(63.7%) | | |
| No idea | 65(21.7%) | | |
| Insecticides cause side effects on non-target species? | | | |
| Yes | 228(76.0%) | 81.12 | 0.000 |
| No | 72(24.0%) | | |
| Insecticides are source of pollution? | | | |
| Yes | 20(6.7%) | 191.22 | 0.000 |
| No | 209(69.7%) | | |
| No idea | 71(23.7%) | | |
| Insecticides have any effect on Agricultural products? | | | |
| Yes | 45(15.0%) | 121.02 | 0.000 |
| No | 189(63.0%) | | |
| No idea | 66(22.0%) | | |
| Insecticides are expensive? | | | |
| Yes | 280(93.3%) | 225.33 | 0.000 |
| No | 14(4.7%) | | |
| Insecticides are cost-effective? | | | |
| Yes | 221(73.7%) | 67.21 | 0.000 |
| No | 79(26.3%) | | |
| Knowledge about insecticides residues? | | | |
| Yes | 30(10.0%) | 74.00 | 0.000 |
| No | 140(46.7%) | | |
| No idea | 130(43.3%) | | |
| Insecticides application cause diseases? | | | |
| Skin allergy | 164(54.7%) | 148.08 | 0.000 |
| Flue | 45(15.0%) | | |
| Cough | 62(20.7%) | | |
| Dizziness | 29(9.7%) | | |

Number of farmers (n=300), answer of each question with their percentage, $\chi^2$ and P-values

***Training, attitude and practices of farmers regarding insecticides*:** Questions were asked to farmers regarding spray application's timing and it was recorded that (n=130, 43.3%) sprayed insecticides in the morning, 36.3% (n=109) in the afternoon, and only 6.0% (n=18) at noon. In terms of insecticide disposal, (n=181, 60.33%) of farmers disposed off empty insecticide containers as regular waste while (n=12, 4.0%) reused containers for other purposes. Regarding the disposal of unused insecticide stock, (n=200, 66.7%) of farmers purchased only the required quantity to avoid waste, and (n=72, 24.0%) released excess insecticides directly onto the ground. A smaller proportion (n=23, 7.7%,) disposed off unused insecticides by draining them into sinks or drains. The use of label instructions was relatively common, with (n=123, 41%) following dosage recommendations and (n=43, 14.3%) followed spraying schedule (Table 4).

It was observed that training on insecticide use and guidance from agricultural extension officers was received by only (n=12, 4.0%) farmers and (n=288, 96%%) did not get any training and guidance (Table 4).

**Table 4. Farmers' count (n) and frequency (%) of the responses for questions regarding training, attitude and practices of insecticides.**

| Questions | n (%) |
|---|---|
| Time for spray application? | |
| Morning | 130(43.3%) |
| Noon | 18(6.0%) |
| Afternoon | 109(36.3%) |
| Evening | 43(14.3%) |
| Doses of spray used? | |
| Recommended | 213(71.0%) |
| Not recommended | 87(29.0%) |
| Protective tools used during spray? | |
| Gloves and Mask | 128(42.7%) |
| Do not wear any protective equipment | 172(57.3%) |
| Where farmers discard insecticides empty containers? | |
| Throw on land away from residential area? | 35(11.7%) |
| Discard with regular wastes | 181(60.3%) |
| Discard empty containers | 72(24.0%) |
| Reuse for other purposes | 12(4.0%) |
| Where farmers discard old stock solution of insecticides? | |
| Discard on ground | 72(24.0%) |
| Dump with container | 5(1.7%) |
| Purchased required amount | 200(66.7%) |
| Discard in drain? | 23(7.7%) |
| Label instructions? | |
| Dose | 70(23.3%) |
| Unable to read | 123(41.0%) |
| Maintain containers | 64(21.3%) |
| Schedule | 43(14.3%) |
| Training received from agriculture extension officers? | |
| Yes | 12(4%) |
| No | 288(96%) |

Number of farmers (n=300), category of each question was with their percentage

**Table 5. Farmers' count (n) and frequency (%) of the responses for questions with respect to Biological control methods.**

| Questions | Yes n (%) | No n (%) | $\chi^2$ | P-value |
|---|---|---|---|---|
| **Knowledge about Biological Control?** | 103 (34.3) | 197 (65.7) | 29.453 | .000 |
| **Knowledge about IPM?** | 91 (30.3) | 209 (69.7) | 46.413 | .000 |
| **Is there any relation predator and pest?** | 228 (76.0) | 72 (24.0) | 81.120 | .000 |
| **Is biological control cost-effective?** | 169 (56.3) | 131 (43.7) | 4.813 | .028 |
| **Do you prefer biological control over insecticides?** | 94 (31.3) | 206 (68.7) | 41.813 | .000 |
| **Does biological control have a positive impact on environment?** | 199 (66.3) | 101 (33.7) | 32.013 | .000 |

Number of farmers (n=300), category of each question was yes, no, with their $\chi 2$ and P-values

***Knowledge of Farmers Related to Biological Control Methods*:** Concerning biological control methods for pests, (n=197, 65.7%), claimed that they had no idea about biological control strategies while (n=103, 34.3%) acknowledged familiarity with this concept. Farmers with this (n=101, 33.7%) responded that biological control methods have no positive environmental impacts (Table 5).

## DISCUSSION

Developing effective action plans and strategies to reduce insecticide load and more appropriate insecticide application techniques necessitates an in-depth understanding of farmers about wise use of insecticides and biological control agents. It is It is important to find out what factors lead to insecticides utilization and its associated health risks. This study aimed to assess these factors among farmers in Narowal, Pakistan. Present study showed that 97.7% farmers were male while 2.3% were female. A similar study conducted in Nigeria (Oluwole and cheke, 2009), indicated that 93% farmers were male. These results align with the present study. Similar results were also recorded by Lekei *et al*. (2014), 93% farmers were male. During farming gender specific challenges that exist between men and women are due to their quality of life, amount, type of work they do, their literacy levels, their economic and social standing. Females mostly have to face challenges like they have less access to, and control of, resources, mostly engaged in household tasks, societal norms and less rights to work (Fawehinmi and Adeniyi, 2014).

Educational attainment among farmers is a key factor in their farming practices, particularly in understanding insecticide labels and safety instructions. In the present study, 29.3% of farmers were illiterate whereas Yassin *et al*. (2002) reported that 8.5% of farmers were illiterate in Philistine. Similar educational patterns were observed by Khan and Iqbal (2005), who inferred that majority of Pakistani farmers have low educational levels.

The farming experience has also significant role in the use of effective practices. In the present study, 37.0% of farmers had been farming for 7-9 years, with 7% having more than 25 years of experience. Similar trends were reported by Mubasher *et al*. (2019), who observed that 41% of farmers had 11-15 years farming experience. Various studies revealed that sociodemographic characteristics of farmers, such as gender, age, education level, and farming experience, significantly affect insecticide utilization.

Khan and Dalamas (2015) reported that 73% of farmers do not able read the instructions on insecticide labels. The current study showed the inability of farmers (45%), to read the instructions on insecticide labels. Similarly, Mubasher *et al.* (2019) reported that 48.2% of farmers faced the same issue.

Despite their experience, many farmers remain unaware that insecticides pose risks to human health and threaten environmental sustainability. Damalas *et al*. (2008) emphasized that improving farmers' risk perception can significantly reduce insecticide poisoning incidents. Farmers often perceive insecticide symptoms as mild and temporary, without understanding the potential for more severe internal damage.

Farmers in this study also reported common health issues such as skin irritation, throat, and nose discomfort, which are in accordance with the following studies, Tanzanian farmers experienced similar symptoms (Lekei *et al*., 2014), while Ngowi *et al*. (2007) noticed that 68% of farmers experienced neurological and skin issues due to insecticide use.

Implementing protective measures is important regarding the use of insecticides in a sustainable way. Similarly, Integrated Pest Management, efficient irrigation techniques, and alternative pest control strategies, such as biological control agents, are fundamental components of sustainable agriculture. Lack of protective equipment use is another important issue. Studies in Greece and India have shown a correlation between knowledge and utilization of protective equipment (Tsakiris *et al*., 2023). Clark *et al*. (1997) observed that farmers in tropical regions often avoid protective gear due to uncomfortable weather conditions. In this study, only 42% of farmers used protective equipment while applying insecticides. These findings are consistent with previous research by Hashemi *et al*. (2010) in Iran, where 40% of farmers used protective equipment.

In the present study, most farmers discarded empty insecticide containers in an unsafe manner, leading to contamination in environment through runoff and aerial distribution of residues. This practice is prevalent in developing countries. Similar studies in Tanzania and South Africa have reported that farmers had been using empty insecticide containers for domestic uses (Lekei *et al*., 2014).

It was reported that most of respondents had not received trainings from extension officer about the use of insecticides as Aldosari *et al*. (2017) found that 79.5% of farmers did not receive any training whereas 12.3%, 5.1% and 3.1% received 2 to 4 and more than four trainings, respectively. While 96% of farmers did not received any training regarding insecticides application during present study. These results are in accordance with the study (Negatu *et al*., 2016) conducted in Ethiopia where 85% of the farmers had not training regarding application of insecticides. A study conducted in the UK on the risk assessment of safe insecticide use among workers found that proper training and the implementation of appropriate safety measures can significantly reduce health hazards (Oztas *et al*., 2018).

Alternative pest control method is a significant component of IPM and plays significant role in ecosystem sustainability but unfortunately it is identified as less frequently used than recommended. Current study reported that (69.7%) farmers had no knowledge regarding alternative methods. Moreover, 65.7% of farmers were unfamiliar with biological control, a sustainable alternative to chemical insecticides. These findings are consistent with the study of Lekei *et al*. (2014) and Yassin *et al*. (2002), who reported low awareness of non-chemical pest control methods.

***Conclusion*:** This study provides valuable insights about the knowledge, perceptions, and farmers' practices in Punjab, Pakistan, regarding insecticides application and adoption of biological control methods. The results highlight lack of awareness and the adoption of risky practices that aid to both health risks and pesticide resistance. To reduce reliance on chemical insecticides, comprehensive programs promoting alternative pest control methods, such as biological control, are immediately needed. Awareness campaigns targeting rural areas, along with farmer training on safe insecticide disposal, are important to mitigating these risks and promoting sustainable agricultural practices.

***Conflict of interest*:** The authors confirm that they have no conflicts of interest.

***Author's Contribution Statements*:** WS executed this survey and wrote this manuscript, NE Review this document, UI and AK proofread this.

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