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Farmers Perception and Knowledge for Management Practices of Fall Armyworm (*Spodoptera frugiperda* Smith) in Lower Shivalik Foothills of Punjab, India

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***Abstract*:** This study aimed to gather information about farmers perception, knowledge and management practices of the introduced insect pest, the fall armyworm *Spodoptera frugiperda* (FAW) A total of 100 smallholder farmers with experience in maize cultivation were surveyed using questionnaire from village Bhattlan and Bhambowal. Most farmers use hybrid varieties (67%), while others rely on local maize varieties (33%). Very few farmers were unable to morphologically identify fall armyworm (FAW) (22%). Most farmers have experienced FAW damage in their farms (97%). Maize is mostly planted in June (when rain starts) by 94% of farmers and the highest infestation period is believed to be between July to August when crop is young and most preferred by FAW. Among those using chemical insecticides to fight FAW, their primary source of insecticides is dealers' shops (85.5%). The majority of farmers spray by themselves (81%). Only 24% farmers reported that they use the recommended dose of insecticides for management of fall armyworm in maize. Although farmers are aware of the presence of FAW in maize fields, the majority of them are unaware about the recommended insecticides and spray technology, which probably affects their ability to control the pest. Awareness campaigns addressing the issues of identification and control of the pest should be implemented targeting smallholder farmers.

***Keywords*:** Fall armyworm, Perception, Sub-mountainous, Survey

Maize (*Zea mays* L) being one of the versatile emerging crop with wider adaptability under different agro-climatic environmental conditions (Manjanagouda and Kalyanamurthy 2018). Maize is a used in the form of food, fodder, feed and industrial raw material. Globally, around 1147.7 million metric tonnes of maize is produced from 193.7 million hectare with an average yield of 5.75 tonnes per hectare in 170 countries (Meena and Nirupma 2021). In Punjab maize occupied 93.3 thousand hectares, with a production of 410 thousand tonnes with average yield was 43.93 quintal per hectare during 2022-23 (Anonymous 2024). Insect pests are amongst the major biotic constraints causing losses in quantities and qualities in the maize crop (Singh and Singh, 2018).Among different insect pest fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) is a noctuid moth that originates from tropical and sub-tropical America (Agboyi et al., 2020). It is a polyphagous pest, known to be a dominant feeder of maize and other cereals (Montezano et al., 2018). This pest has been reported in 100 countries across the globe including India (Baloch et al., 2020). In India, fall armyworm, *Spodoptera frugiperda* (FAW) was first reported from Karnataka in 2018 and in2019 from Punjab (Sharanbassapa et al., 2019, Jitendra et al., 2019, Kerketta et al., 2020). In general, the maize infestation by FAW ranged from 26.4 to 55.9 per cent and impacted yield of 11.57 per cent (Baudron et al., 2019, Balla et al., 2019, Prasanna et al., 2018). Crop losses due to insect pests may be prevented, or reduced, by deploying effective crop protection measures, which to a large extent depend on farmers' knowledge and behaviour towards pest management (Kansiime et al., 2019, Kumela et al., 2018). In cases of economically important and invasive insect pests such as FAW, it is crucial to know how familiar farmers are with the pest, what options they have to control it and what are their main constraints and proper identification of natural enemies which are prevailing in their area. Surveys designed to ascertain farmers' knowledge and practices regarding pest management are important for pest control (Kansiime et al., 2019). Keeping these points in mind, the present study was aimed to assess perception, the knowledge, and management practices of FAW among farmers of sub-mountainous area of Punjab, India.

MATERIAL AND METHODS

This study was carried out in two villages Bhambowal (31°45'27.4"N, 75°47'51.8"E) and Bhattlan (31°56'24.0"N, 75°07'48.0"E) of district Hoshiapur Punjab India. In these areas maize is the main *kharif* crop and is cultivated in rainy season. The rainy season starts from June to July. Maize is often grown in small plots (less than 1 ha), in different cropping systems. In general, very less fertilizers or pesticides are used for the production of maize by

smallholders. The survey was conducted from June to October during 2023. At the beginning of the survey, farmers were informed of the aim of the study. The survey was conducted among 100 farmers (50 in each village). Data of both villages were pooled. Information related to farmers' socioeconomic characteristics (age, gender, education level, monthly income, number of farms and land possession per household), knowledge and perceptions about FAW (morphological identification, recognition of attack symptoms, incidence and spread of the pest), management practices (methods of control, handling of insecticides) and constraints for its control were collected. Data were summarized per village. For each question, similar answers were grouped and the percentage of farmers who gave similar responses was determined for each village. Whenever two or more responses were given to the same question, they were again grouped by similarity and the percentage of farmers who gave a similar response was determined for each village. The two or more responses were given to the same question, were grouped by similarity and the percentage of farmers with similar response was determined for each district. In some cases, the percentage of farmers was determined based on the total number of farmers who gave a particular response (Canico et al., 2021).

RESULTS AND DISCUSSION

This study aimed to gather information about farmers perception, knowledge and management practices of the introduced insect pest, the fall armyworm *Spodoptera frugiperda*.

Socio-economic characteristics: The socio-economic characteristics are given in Table 1.

Cropping systems, maize varieties, purpose of production, recognition of FAW attack: Most farmers (94%) have more than 10 years of experience in maize cultivation in both villages. The primary source of maize seeds was from pesticide dealers (90.75%) and most farmers use hybrid varieties (67.The pooled data of Bhambowal and Bhattlan, depicted 92.5 of farmers plant maize as monocrop while remaining 7.5% prefer intercropping of maize with other crops.. The majority of farmers in these villages reported that they produce maize for both home consumption and sale (88%) (Table 2). About 99.5% of farmers in these villages reported incidence of FAW, but very few of them are unable to distinguish FAW larvae from other lepidopteran larvae (22%). The maize is mainly planted in June which coincides with the beginning of the rainy season. The incidence of FAW is reported to be high between July to August as in this period, maize plants are still young. Most farmers apply chemical insecticides (90%) and 10% farmers apply any other method of control of FAW like pheromone traps etc (Table 2).

Management and application of insecticides: Among those using chemical insecticides to control FAW, their primary source of insecticides is authorized dealers' (85.5%). But in some cases, insecticides are acquired by Agriculture/Horticulture Department (14.5%). The majority of farmers in these villages spray the insecticide in their fields by themselves (81%) and very few hire labour for spray (7%). Mostly farmer spray insecticide insecticides in their field but they don't wear protective clothing (90.25%) .Only 24% of the farmers reported that they use the recommended dose of insecticides while majority of farmers either use higher (40%) or lower (26.25%) dose of insecticide. The farmers using chemical insecticides usually mix two or more insecticides (70%) All farmers use backpack sprayers when applying insecticides. The common spraying intervals used by farmers are fourteen days and twenty one days. About 67% of farmers applying insecticides reported that the insecticides used are not efficient in the control of FAW. Despite the reported use of insecticides, farmers do not have training in pesticides use for management (34.50%). Although the number of sprays can go up to 7 sprays per crop cycle, but farmers generally spray 4-5 per crop cycle (93%). In the average number of sprays per crop cycle is 4.5. Most farmers reported appearance of pest as the basis for deciding to

Table 1. Socio-economic characteristics of farmers

Characteristics of respondents	Number of responses
	Bhambowal & Bhattlan (n = 100)
Gender	
Women	27
Men	73
Age/gender (years)	
Women	45
Men	47.50
Number of individuals/household	4.25
Education level	
No education	13.5
Primary education	50
Secondary education	27
Graduation	9.5
Another occupation excluding Agriculture	
Yes	41
No	59
Land possession/household (hectare)	0.78

apply insecticides (45%) but very few (27%) apply insecticide as per recommendations (Table 3).

The educational background of farmers seems to play a major role in their ability to get al.,ternative/additional jobs. Int his study no relationship was established between the level of education and knowledge of FAW, Abtew et al. (2016), pointed out the importance of education in farmers' level of knowledge of agricultural pests

Toepfer et al. (2019) reported that invasive alien species represent a serious challenge in the context of pest management because farmers and local agricultural extension workers rarely know about the presence of a newly arrived and spreading species until more damage occurs this is line

Table 2. Farmers' experience in seed procurement, maize cultivation and FAW incidence

Characteristics of respondents	Number of responses
	Bhambowal & Bhattlan (n = 100)
Seed provenience	
Authorized dealer	90.75
Own seed (previous season)	5
Neighboring farmer	1.75
Agric Department 2.5	
Experience in maize cultivation	
Between 5 and 10 years	6
More than 10 years	94.0
Type of maize variety	
Hybrid	67
Local/recommended	33
Cropping pattern	
Monocrop	92.5
Intercrop	7.5
Purpose of production	
Home consumption	5.5
Sale	6.5
Both	88
Observation of FAW larvae	
Yes	99.5
No	0.5
Ability to identify FAW larvae morphologically	
Can identify	78
Month of Sowing of maize	
Normal sowing (June)	94
July	6
Maximum Incidence of FAW	
July-August	100
Methods of control of FAW	
Chemical method	90
Using non chemical methods (pheromone traps etc.)	10

Table 3. Use of insecticides among farmers

Characteristics of respondents	Number of responses
	Bhambowal & Bhattlan (n = 100)
Source of insecticides	
Authorized dealer	85.5
Agriculture department	14.5
Spraying	
Farmer himself	81
Another family member	12
Someone hired	7
Use of protective equipment	
Partially equipped	9.75
Without any equipment	90.25
Dose of application of insecticides	
Recommended	24
Increased	40
Reduced	26.25
Unknown	9.75
Mixture of insecticides	
Mix	70
Application equipment	
Spraying interval	
7 days	14.50
14 days	48.50
21 days	28.50
30 days	8.50
Training in the handling of insecticides	
Trained	65.50
Non-trained	34.50
Application of insecticides based on	
On appearance of pest	45.0
Recommendation	27
Observation of neighboring farmers	28
Efficiency of insecticides	
Efficient	33
Not efficient (low quality)	67
Number of sprays of insecticide for FAW management in crop season	
1-3	3
4-5	93
6-7	4

with present studies where FAW an invasive pest caused high damage until farmers were aware about its biology or behaviour.

The infestation of FAW in maize fields is reported to be high between July and August. This can be explained by the fact that in this interval, maize planted in June is still in the vegetative stage which is the most preferred by FAW. Despite recommendation from the Agricultural Uniiversity to use a select range of insecticides to fight FAW (Cheema et al., 2021), only about 24% farmers in survey apply insecticides as per recommendation.

Concerning the specific case of FAW, several methods of control of the pest are reported in many countries where farmers use chemical, cultural and biological control (Kansiime et al.,. 2019), Ethiopia and Kenya where among other methods, farmers use physical and traditional methods (Kumela et al.,. 2018). It was found that cultivation of tolerant genotypes, adjusting sowing windows, and practicing specific intercultural and cropping systems measures in addition to chemical and non-chemical pest management strategies showed encouraging results for sustainable management of fall armyworm, which could protect the crop (Kumar et al., 2022). Many natural enemies have been identified in Punjab ecosystem against this pest (Bhargav et al., 2022). In this study, in contrast to other countries, chemical control was the only method used by a limited number of smallholder farmers. Further farmers are not properly using spray technology for its management. Sustainable strategies to manage this voracious insect can be in the form of cultural practices, mechanical control, botanical and insecticide applications, biological control, and host plant resistance. Biopesticides like Bt sprays, insecticides such as chlorantraniliprole, emamectin benzoate and spinetoram, and mixed cropping can be integrated for the effective management of this pest (Jindal et al., 2022). In a study conducted in Punjab during 2020, native parasitoids of *Chilo partellus* such as *Campoletis* spp. and *Chelonus formosanus* have been recorded on fall armyworm as well (Jindal et al., 2021) Furthermore, when biopesticides are combined with good crop management, they can keep pest levels under control (Bateman et al., 2018. Jindal et al., 2022). Surveys designed to ascertain farmers' knowledge and practices regarding pest management are important because they can highlight the need for the training of farmers in the identification of pests and the debunking of pest management misconceptions (Arshad et al., 2009). Understanding these factors is critically important for setting a research agenda, designing extension strategies, and formulating research that meets farmers' demands

CONCLUSIONS

Although farmers are aware of the presence of FAW in their maize fields and the majority of them are able to morphologically distinguish FAW from other caterpillars but spraying of unrecommended insecticides probably affects their ability to control the pest. Nevertheless, most farmers believe that the incidence of FAW is spreading but they are not able to manage this pest despite giving 4 to 5 sprays of insecticides. Farmers are not trained in spraying insecticides for management of fall armyworm and not spraying the recommended insecticide at proper dose and right time rather they mix the insecticides for getting rapid control. There is need to educate smallholder farmers regarding use of recommended insecticide and method of insecticide spray, time of spray, other method for management etc. effective management of this pest.

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