FALL ARMYWORM, *Spodoptera frugiperda* (J.E. Smith) DAMAGE SEVERITY ON MAIZE CROPS IN FARMERS' FIELD CONDITIONS IN KATHMANDU VALLEY

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ABSTRACT

Maize, a major staple crop that is essential for Nepal's food security and rural livelihoods, is increasingly threatened by the invasive fall armyworm (Spodoptera frugiperda J.E. Smith), which causes substantial yield losses while farmers' heavy reliance on indiscriminate pesticide use and limited knowledge of sustainable management practices obstruct effective control. Field survey was carried out in six major maize-growing areas of Kathmandu valley- Kathmandu, Bhaktapur and Lalitpur districts to assess the fall armyworm, Spodoptera frugiperda (J.E. Smith) incidence, severity and farmers' management practices during maize growing season in 2024. Semi-structured questionnaires were used for farmer interview , and damage assessment in the field was recorded using a score ranging from 1 to 9 scale based on the reference damage on the scaling of the leaf lesions, scraping of leaf surfaces and visual observations of the damage symptoms. Data analysis and result interpretation were carried out using MS Excel 2016 and SPSS version 29.0.2.0. Results indicated that maize crop damage incidence and severity varied significantly ($p<0.05$) with $p<0.001$ at vegetative and $p=0.005$ reproductive stages. Damage severity was highest in V11 stage during vegetative stage and dough (R4) stage during reproductive stage of maize crop. Similarly, in relation to temperature, the damage was more at temperature range of 25°C to 27°C. The highest infestation (91%) was observed in Kathmandu compared to other two districts. The survey indicates that maize farmers have to focus on agro-ecological adoption approaches like chemical, cultural, physical/mechanical, IPM, biological, and botanical measures for the management of this pest.

1.INTRODUCTION

Internally displaced persons (IDPs) are Maize (*Zea mays* L.) is a versatile crop grown across a wide range of agro-climatic zones. It thrives from 58°N to 40°S and at altitudes from sea level to 3,000 m, from the sea level with annual rainfall requirements that span roughly 250–5,000 mm (CIMMYT 2023,; FAO 2023). Globally, maize is cultivated in more than 160 countries on about 197 million hectares, contributing nearly 1.2 billion tonnes of grain and accounting for around 35–36% of total global cereal production (FAO, 2023; OECD-FAO, 2023). The United States remains the largest maize producer, contributing about one third of global production (FAO, 2023; Solaimalai et al., 2020).

The crop is widely cultivated in Nepal, particularly in the mid-hills and Terai regions. However, it is predominantly grown in the hills, where farm sizes are generally smaller compared to the Terai (Gairhe et al., 2021). Globally, maize ranks among the top cereal crops in terms of production and trade, alongside wheat and rice (Erenstein et al., 2022). Moreover, the contribution of cereal crops in national GDP of Nepal accounted about 8.24% in the fiscal year 2020/21 (MoALD, 2020/21). It ranks the second after rice with contribution of GDP 6.83% in the fiscal year 2020/21 In Nepal, maize is cultivated over an area of approximately 0.98 million hectares, with a total production of around 3.0 million tonnes and an average productivity of about 3.15 t/ha (MoALD, 2022/23); far lower than the global yield of 5.71 Mt/ha(FAO 2023; MoALD 2022/23)

In the hills, more than 86% of the maize produced is used for human use, and 80% of the Terai produced is used as animal feed, with the remaining 10% being used in industries and human consumption (Timsina et al., 2016). Furthermore, in the hills and mid-hills, 60% of the grain produced is used for animal feed, 25% for human use, and 3% for seed and the remaining 12% is marketed (Ghimire et al., 2019). The amount of maize consumed per person per day in Nepal was calculated 98 g/person/day (KC et al., 2015; Ranum & Pe, 2014). This crop can grow during both short- and long-day periods and is photo-insensitive (Coles et al., 2010). Maize contains nearly 72% starch, 10% protein, and 4% fat. Its caloric density is 365 kcal/100g (Ranum and Pe, 2014).

A review was made on the notorious insect pest fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) which has potential to cause maize yield losses of 20-25% (Badhai et al., 2020). For the pest to be established, the temperature during pre-monsoon, monsoon and post monsoon is highly favorable. According to reports, *S. frugiperda* larvae can consume 353 different plant species, but in Nepal, the pest poses a serious threat, particularly to the maize crop due to the country's moderate climate, vegetation, staggered and scattered maize planting, all of which make it ideal for the pest to establish itself (Sah et al., 2020). Despite its widespread occurrence, it is mostly found in areas with very low frost cover, a minimum annual temperature of 18–26 °C, and 500–700 mm of rainfall (Early et al., 2018). Given the economic and food security importance of maize and the increasing threat posed by *S. frugiperda*, there is a pressing need for effective and context-specific pest management strategies. This study aimed to assess the incidence and severity of *S. frugiperda* infestation and to document farmers' existing management practices. Specifically, the objectives were to: (i) determine the prevalence and distribution of *S. frugiperda* across selected sites, (ii) evaluate the level of infestation and crop damage in farmers' fields, and (iii) analyze the pest management strategies adopted by farmers to control this pest.

2.MATERIALS AND METHODS

2.1 Study area

Survey and field-based studies were conducted in selected municipalities of the Kathmandu valley, representing the major maize-growing areas with a history of fall armyworm occurrence. Kathmandu, Lalitpur and Bhaktapur districts were purposively selected because maize is widely cultivated in these districts under diverse agro-ecological conditions, making thm suitable for assessing FAW incidence, severity and farmers management practices. Within the selected municipalities, farm sites were chosen using simple random sampling to ensure unbiased representation. Field damage assessmens were conducted in Tarakeshwar Municipality (Kathmandu), Khumaltar(Lalitpur),and Madhyapur Thimi (Bhaktapur) For the farmer survey, five municipalities were selected: Tarakeshwar and tokha in Kathmandu, Mahalaxmi in Lalitpur, and suryabinayak and Madhyapur Thimi in Bhaktapur (Figure-1)

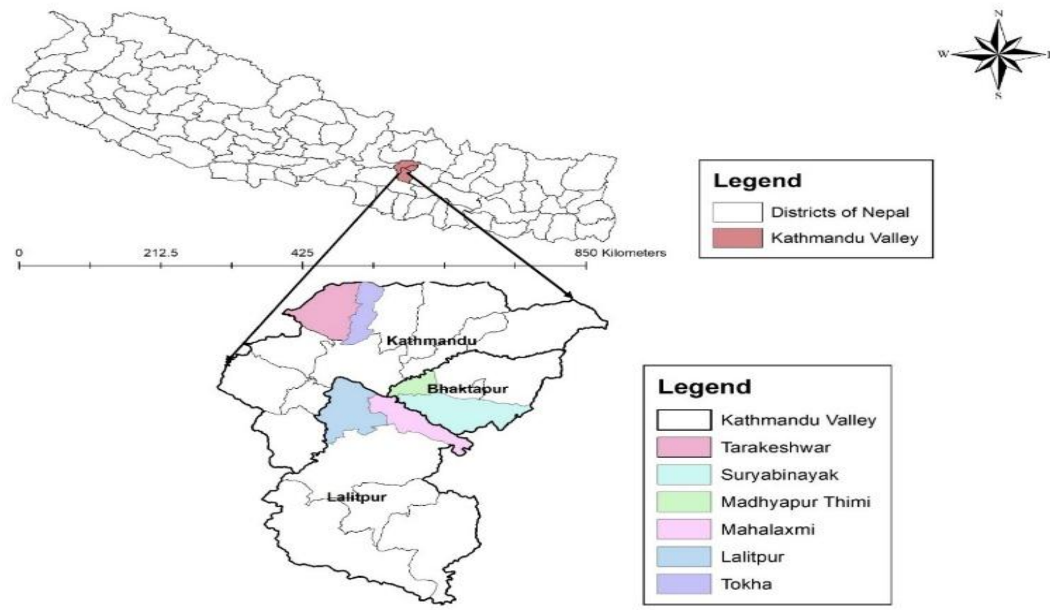

Figure 1: Map of study area

2.2 Questionnaire survey

The survey was conducted across five municipalities in the Kathmandu Valley, encompassing Kathmandu, Bhaktapur, and Lalitpur districts. Respondents were selected from maize-growing households with the assistance of municipal agriculture offices and local farmer groups, and only farmers who cultivated maize during the 2024 season were included in the survey. A simple random sampling approach was then used to select respondents from the prepared list of eligible maize growers. A total of 90 maize-growing farmers were selected, with 15–20 respondents sampled from each municipality. Specifically, 40 respondents were selected from Kathmandu district (20 each from Tarakeshwar and Tokha municipalities), 20 respondents from Mahalaxmi municipality in Lalitpur district, and 30 respondents from Bhaktapur district (15 each from Suryabinayak and Madhyapur Thimi municipalities).

Data were collected using a semi structured questionnaire comprising both closed- and open-ended questions. Closed-ended questions were employed to obtain information on pest identification, the prevalence status of *Spodoptera frugiperda*, and infestation levels across different maize growth stages. In addition, semi-structured open-ended questions were used to gather detailed information on fertilizer application practices, pest management strategies, and farmers' perceptions of crop damage.

Table 1. Number of farmers across municipality and total number of maize growers in each municipality

Area/District	Municipalities	Number of Respondents	Estimated Maize Growers (HH)
Kathmandu	Tarakeshwar	20	~800 – 1,200
	Tokha	20	~500 – 900
Lalitpur	Mahalaxmi	20	~600 – 1,000
Bhaktapur	Suryabinayak	15	~400 – 700
	Madhyapur Thimi	15	~300 – 600
Total		90	

Source: Field Survey and Estimated maize growers s (CBS,2021)

2.3 Data recording

Data on *S. frugiperda* infestation patterns and damage severity in maize were collected from June to August 2024. Observations included different growth stages of the crop, taking into account the prevailing weather conditions during each sampling period. Data were recorded on a weekly basis using a standardized scoring sheet (Davis et al., 1992; Ni et al., 2011). In total, 14 farms across the three districts were included in the study, with 10 plants randomly selected from each field for observation. During the vegetative stage, field scouting followed a "W" sampling pattern, where damage levels were systematically observed and recorded. During the reproductive stage, data were collected using a ladder sampling pattern (Prasanna et al., 2021).

Table 2. Damage scoring by sampling of farmers maize growing fields

Score	Description/Symptoms
1	Healthy plant/ No damage/Visible Symptoms
2	Few short/pin sizes holes/scraping on a few leaves (1-2)
3	Short/pin size holes/scraping on several leaves (3-4)
4	Short/pin size holes/scraping on several leaves (5–6) and a few long elongated lesions (1–3 Nos) up to 2.0 cm in length present on whorl and or adjacent fully opened leaves
5	Several holes with elongated lesions (4–5 Nos) up to 4.0 cm in length and uniform/ irregularly shaped holes present on whorl and or adjacent fully opened leaves
6	Several leaves with elongated lesions (6–7 Nos) up to 6.0 cm in length and uniform/ irregular shaped holes present on whorl and adjacent fully opened leaves
7	Several long lesions (>7 Nos) up to 10 cm in length and uniform/irregular shaped holes common on one-half of the leaves present on whorl and adjacent fully opened leaves
8	Several long lesions >10 cm in length and uniform/irregular shaped holes common on one half to two-thirds of leaves present on whorl and adjacent fully opened leaves
9	Complete defoliation of whorl of the plant

Source: (Davis et al., 1992; Ni et al., 2011)

2.4 Damage severity at different crop stages

Data was recorded observing the visual damage symptoms and infestation pattern on the leaves of 10 maize plants from each farmer's maize field. Damage score was given varying from 1 to 9 following the reference table of damage score (Davis et al., 1992; Ni et al., 2011). Data was recorded for ten weeks maintaining the weekly interval in the fields chosen for study. For the damage severity evaluation, average field damage score was calculated district wise (Table 2)

2.5 Level of maize crop damage

Damage level and its severity were determined following the 1 to 9 rating scale (Davis et al., 1992; Ni et al., 2011) where the higher ratings were based on the length of the lesions on the leaf. The damage rating varied from 1 (healthy plant/no damage/visible symptoms) to 9 (complete defoliation of whorl of the plant). For each plant, the stage of the plant was determined during both vegetative and reproductive stages. The plants were selected following the pattern recommended during field scouting (Prasanna et al., 2021). The infestation patterns by *S. frugiperda* were identified based on the visual observation and scored scale measurement of the lesions, and damage severity**.**

2.6 Primary data

The primary data encompass quantitative data that was collected through field research in various municipalities of Kathmandu valley. The quantitative information was concerned with *S. frugiperda* infestation patterns and damage levels in maize fields. The qualitative data for the study was collected through a household survey. Various maize growing farming sites were selected for the study with the consultation of Agriculture Knowledge Center (AKC), Lalitpur and Plant Quarantine and Pesticide Management Center (PQPMC), Hariharbhawan, Lalitpur.

2.7 Secondary data

Data related to the study was collected from related publications on *S. frugiperda* infestation patterns and damage severity in maize crops. Various books, journals, research papers, proceedings, annual publications of different institutions from internet and other sources were used as sources of secondary data for the study.

2.8 Statistical analysis

The data collected from the field scouting was first recorded in MS Excel 2016 and analyzed using software SPSS version 29.0.2.0 (20). The collected data for respective study parameters were classified according to the required values, like mean and standard error. One-way analysis of variance (ANOVA) was used to check the significant differences between the groups. Data on temperature was accessed from the online source. The coefficient of determination (R^2) was determined to analyze the variance caused by temperature to the field damage level.

3. RESULTS AND DISCUSSION

3.1 Information about fall armyworm and their damage in maize

As shown in Figure 2, 72% of the respondents were able to identify fall armyworm (*Spodoptera frugiperda*), whereas 28% were unable to identify the pest. This finding is consistent with Kumela et al. (2019), who reported that the majority (99%) of farmers in Ethiopia were aware of *S. frugiperda*. Likewise, Poudel et al. (2023) reported that 59.3% of farmers in Baitadi, Nepal, were able to identify *S. frugiperda* based on visual observation, which is broadly comparable to the findings of the present study

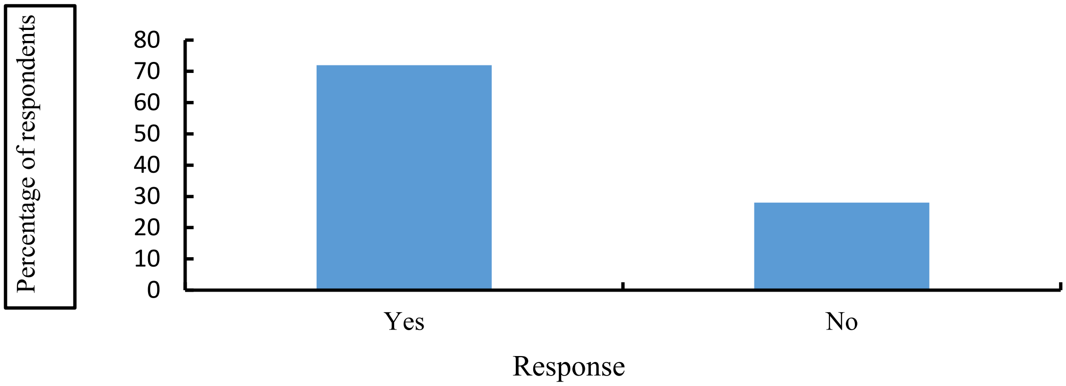

Figure 2 Identification of the fall armyworm, S. frugiperda by maize farmers

3.2 Fall armyworm prevalence in farmers' fields:

Based on two-way interaction between the farmers and the interviewers, it was found that 3% of the respondents had no prevalence of fall armyworm their fields. Three-fourth of the respondents (75%) experienced a moderate level of infestation, indicating a widespread but manageable presence of the pest. Meanwhile, 22% of the respondents reported a high level of infestation in their maize fields, suggesting significant pest pressure in those areas. These findings, as illustrated in Figure 3, highlight that *S. frugiperda* infestation is prevalent across most surveyed fields, with varying degrees of severity.

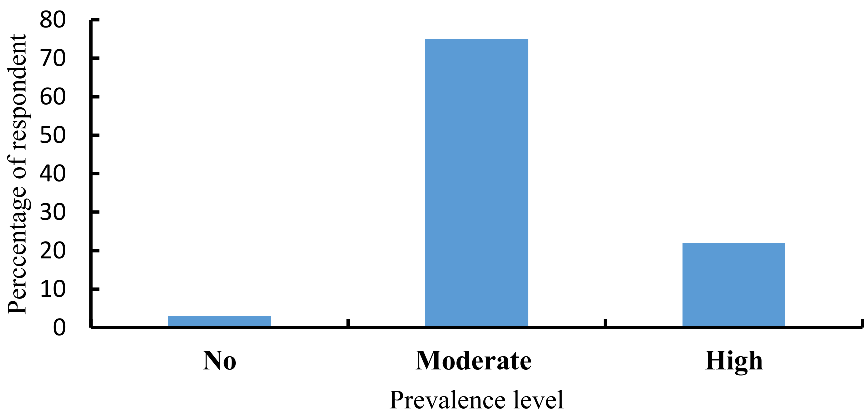

Figure 3. Prevalence status of FAW

3.3 Fall armyworm prevalence at different stages of maize growth

Based on the responses of the farmers and their field experience, farmers reported that *S. frugiperda* damage occurs from seedling stage to the tasseling and silking stages (Figure 4). Infestation was most frequently reported at the knee height stage (40%), followed by the tasseling and silking stages(27%), seedling stage (13%), milking stage (11%), and maturity stage (9%). This finding aligns with the result of Poudel et al. (2023), that highlights that compared to all other pests, *S. frugiperda* causes the most serious damage at vegetative growth stage, tasseling stage, and physiological maturity stage of maize development.

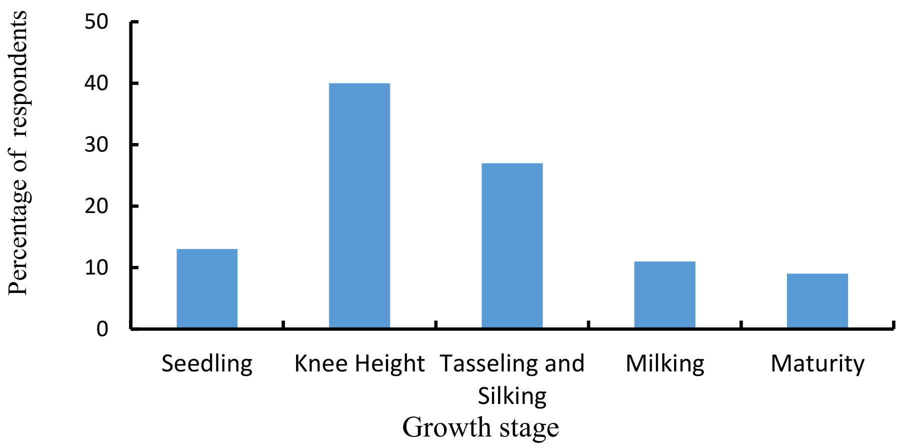

Figure 4. Prevalence status based on growth stage

3.4 ***Fall armyworm damage in 2024 year***

During the survey, data relating to damage caused by *S. frugiperda* in previous year was also evaluated using closed ended questionnaire. Figure 5, depicted tht 31% of the responded believed <10% damage, 47% optioned 10-30% damage, 13% indicated 30-60% damage and remaining 9% viewed >60% damage in 2024. Here, majority of the farmers responded with 10-30% damage which is similar with the findings of Kansiime et al. (2019) where majority of farmers reported with major pest damage level of (10-40%).

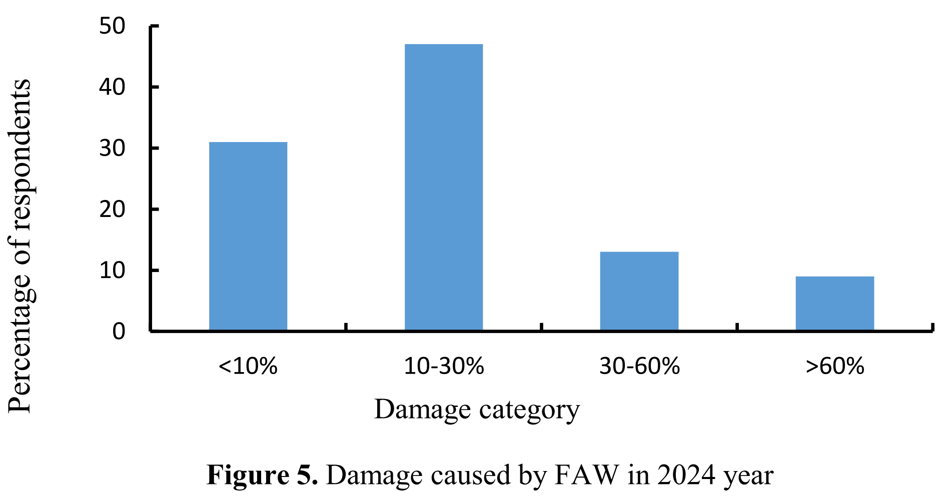

Figure 5. Damage caused by FAW in 2024 year

3.5 *Farmers' practices of fall armyworm management*

The survey revealed that most maize farmers in the Kathmandu valley cultivated maize primarily for household consumption. The majority of farmers were unfamiliar with biological control and integrated pest management (IPM) approaches and relied predominantly on chemical pesticides for pest management. A smaller proportion of farmers adopted cultural practices, including timely weeding, hoeing, and irrigation, as part of their crop management. Overall, 67% of farmers relied on chemical control methods, followed by cultural practices (13%), physical/mechanical methods (7%), IPM (6%), biological control (4%), and botanical measures (3%) (Figure 6).

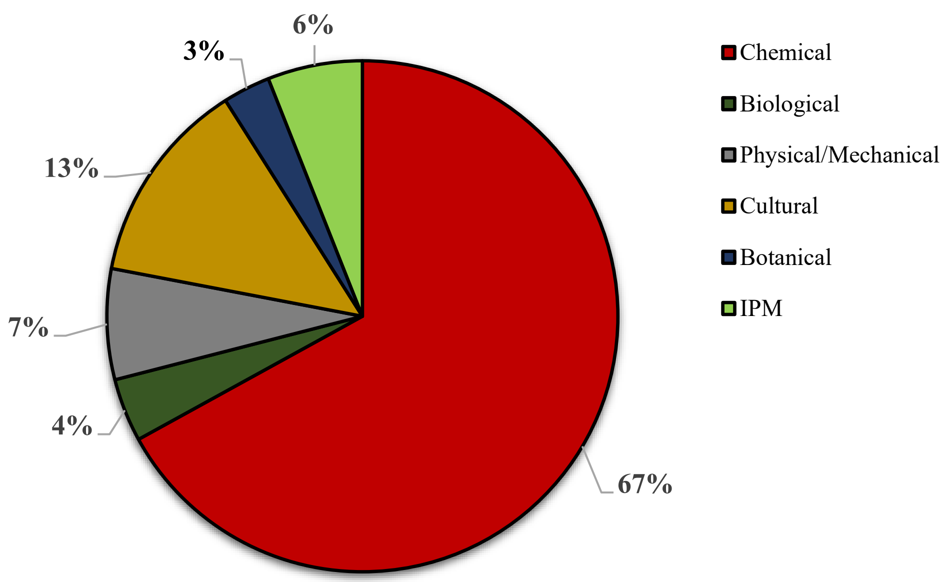

Figure 6. Management practices adopted by farmers

According to Bista et al. (2020), intercropping maize in strips with pigeon pea, cowpea, cassava etc. or other repellant crops aid in reducing the infestation level and reproductive activities in *S. frugiperda.* Yurina et al. (2023) reported that compared to a non-IPM plot, the IPM adopted for fall armyworm in maize was more productive economically beneficial and ecologically friendly.

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3.6 Farmers' source of technical advice

Study showed farmers relying on advice from agro-vets for management of *S. frugiperda* (Figure 7). It was found that 39% of the respondents depended on agro-vets, 22% on mobile apps/digital services, 19% on other maize growers, 17% on media (radio, television, newspaper) and only 3% on the technicians. Bhandari et al. (2021), reported that very few households received extension services regarding fall armyworm and related preventative measures.

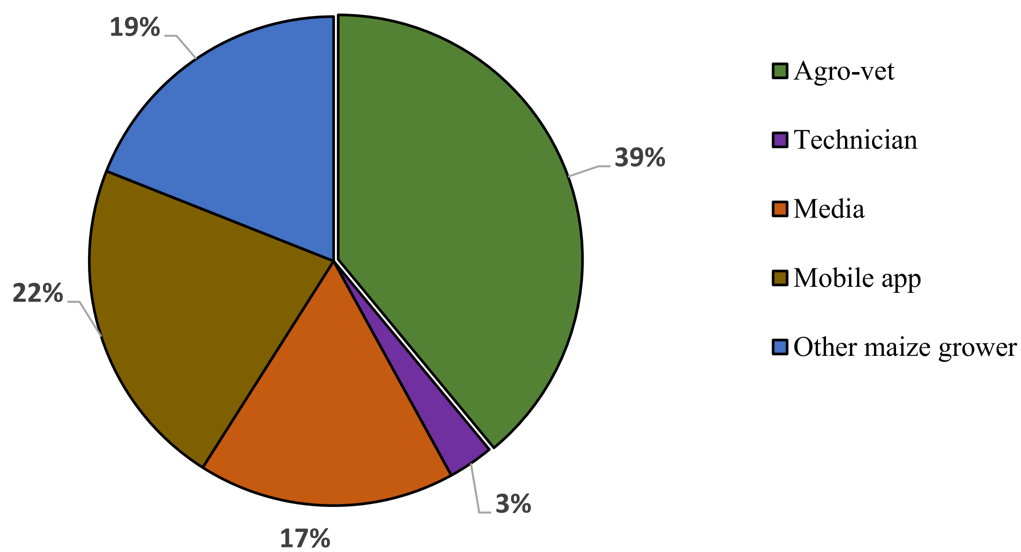

Figure 7. Source of technical advice for pest control

3.7 Maize crop damage severity

Table 3 presents the one-way Analysis of Variance (ANOVA) results comparing average damage score across vegetative growth stages, which differed significantly ($p < 0.05$) at different vegetative growth stages of maize crop.

Table 3. ANOVA table for average field score at vegetative stage o maize crop

Source of variation	Sum of squares	df	Mean square	F	p-value
Between Groups	58.750	13	4.519	48.919	<0.001
Within Groups	2.587	28	0.092		
Total	61.336	41			

Source: Field Research, 2024

Figure 8 presents the results of the one-way Analysis of Variance (ANOVA) comparing the mean damage scores across different vegetative growth stages of maize. The analysis revealed significant differences among vegetative stages ($p < 0.05$), indicating that the level of crop damage varied significantly throughout maize development. Post-hoc mean separation using Tukey's HSD test was performed, and the corresponding grouping letters are shown above the error bars in Figure 8. Vegetative stages sharing the same letter are not significantly different, whereas stages with different letters differ significantly at the 5% significance level. The average damage scores across the three study districts are illustrated in Figure 8. Damage increased progressively with crop growth stage, reaching its highest value at the V11 stage, followed by V12 and VT (tasseling stage). In contrast, the V3 stage recorded the lowest average damage score. The Tukey HSD groupings further indicate that the later vegetative stages generally experienced significantly greater damage than the early vegetative stages. This trend suggests that maize plants become increasingly susceptible to pest injury as they advance through vegetative development.

These findings are consistent with those reported by Omar (2023), who noted that larvae can infest maize throughout the crop growth cycle, causing characteristic leaf-feeding damage accompanied by sawdust-like frass and subsequently damaging reproductive structures. As pest populations build up over time, damage severity tends to increase during the later vegetative stages, potentially resulting in substantial yield losses. Consequently, effective pest monitoring and management should be emphasized during the mid- to late-vegetative growth stages of maize.

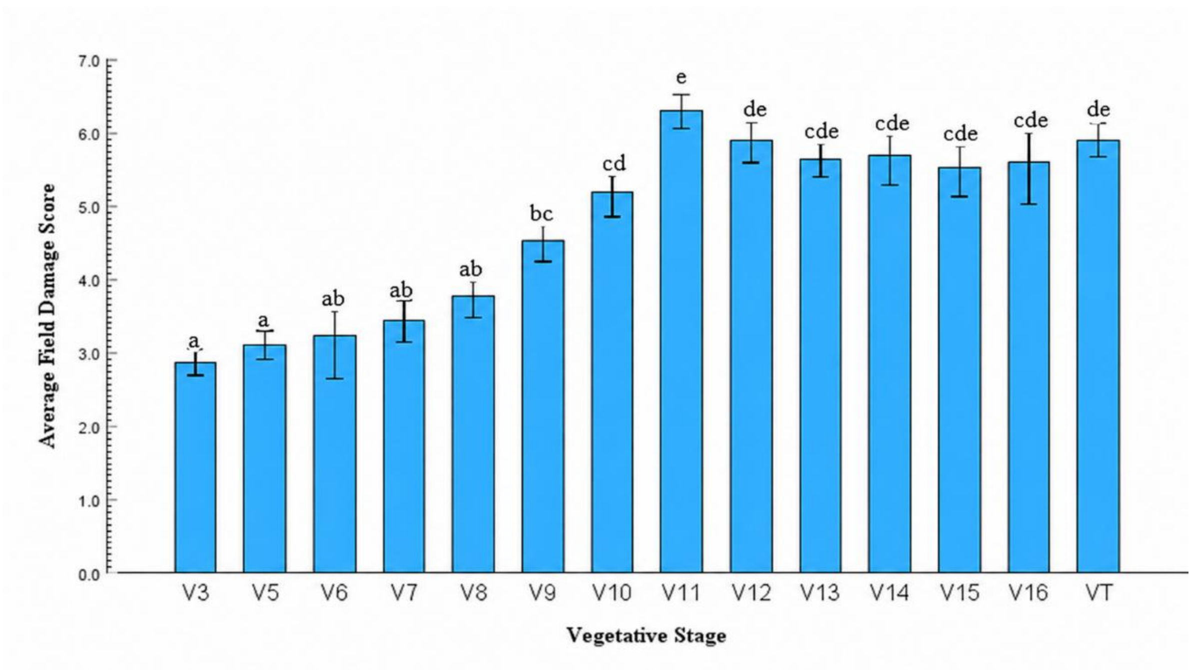

Figure 8- Damage level in vegetative stage

3.8 Damage severity in reproductive stage of maize crops

The ANOVA Table 3 shows the average maize plant damage score at different reproductive stages. There was significant effect in the change of average damage score in relation to the reproductive stage of plant ($p < 0.05$). In the ANOVA table, p-value is lesser than the typical alpha value (0.05) i.e. (Table 4). This suggested that the average field damage score and reproductive stage of plant have statistically significant difference.

Table 4. ANOVA table for average field score at reproductive stage of maize crop

Source of variation	**Sum of squares**	**df**	**Mean square**	**F**	**p-value**
Between Groups	8.143	4	2.036	7.151	0.005
Within Groups	2.847	10	0.285		
Total	10.989	14			

Source: Field Research, 2024

Similarly, Figure 9 shows the average field damage scores across different reproductive stages of the crop- Silk, Blister, Milk, Dough and Dent. The highest average damage score was found in the Dough (R4) stage followed by Milk (R3) and Dent (R5) stage. While the lowest average damage was found in the Silk (R1) stage.

Results of Table 3 and 4, are in line with the findings of Mutyambai et al. (2022), who stated that maize damage levels varied significantly ($p<0.05$) across cropping systems, production systems, soil types, and weeding patterns, where young maize plants were more infected and damaged compared to tasseling and mature plan

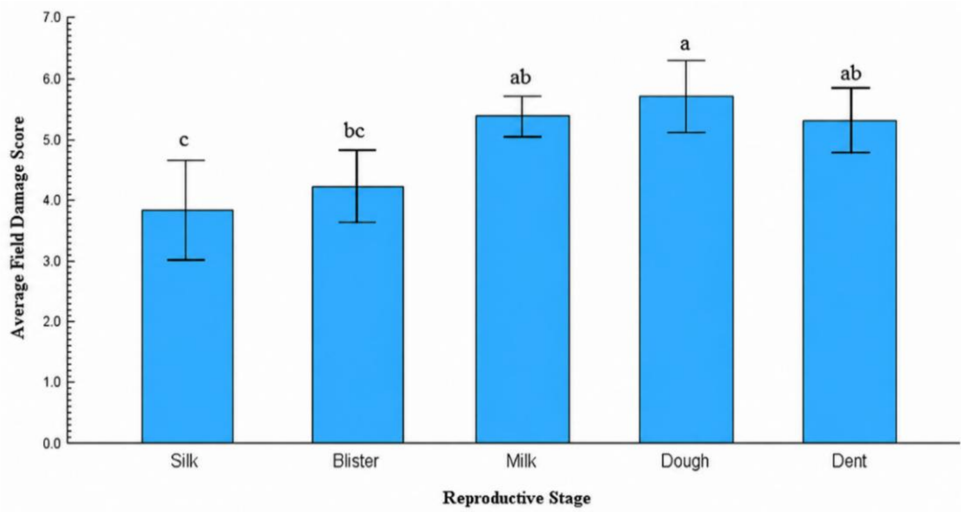

Figure 9: Damage level in reproductive stage

3.9 Fall armyworm infestation level in Lalitpur, Kathmandu and Bhaktapur districts

Infestation level across all three districts were determined from the affected area of land and average damage percentage. The highest average damage percentage was recorded in Kathmandu followed by Bhaktapur and the lowest in Lalitpur district. Data relating to infestation level highlighting affected area of land and average damage percentage in Lalitpur is represented in Table 5.

Table. 5. Comparison of infestation level, affected area, and average damage of Fall armyworm in three districts of Kathmandu Valley

District	Infestation level	Affected area (Ropani)	Average damage (%)	Comments
Bhaktapur	Low	0.88	22	Low infestation, well managed
	Medium	1.04	26	Moderate infestation
	High	1.70	34	Severe infestation observed
Kathmandu	Low	0.96	24	Low infestation, well managed
	Medium	1.74	29	Moderate infestation
	High	2.66	38	Severe infestation observed
Lalitpur	Low	0.42	21	Low infestation, well managed
	Medium	0.72	24	Moderate infestation
	High	1.24	31	Severe infestation observed

Source: Field Survey, 2024

Table 5 shows the average maize damage caused by Fall Armyworm (FAW) under low, medium, and high infestation levels in the three districts of Kathmandu Valley. Across all districts, crop damage increased as infestation severity increased, demonstrating a clear relationship between FAW infestation intensity and maize damage. Among the three districts, Kathmandu experienced the highest level of crop damage at every infestation category. Average damage increased from 24% under low infestation to 29% under medium infestation, reaching 38% under high infestation. These findings indicate that maize fields in Kathmandu were more severely affected by FAW than those in the other districts, which may be associated with higher pest pressure, environmental conditions favorable for FAW development, or differences in crop management and pest control practices.

Bhaktapur recorded moderate levels of crop damage, with average damage rising from 22% under low infestation to 26% under medium infestation and 34% under high infestation. Although the damage was consistently lower than in Kathmandu, the steady increase across infestation levels indicates that FAW remains an important production constraint for maize farmers in the district. In comparison, Lalitpur showed the lowest average crop damage across all infestation categories. Damage increased from 21% under low infestation to 24% under medium infestation and 31% under high infestation. The relatively lower damage observed in Lalitpur may reflect lower infestation pressure, more effective field management practices, or environmental conditions that limited FAW population development.

Overall, the results reveal a consistent pattern of increasing maize damage with increasing FAW infestation severity in all three districts. Kathmandu was the most severely affected district, whereas Lalitpur experienced comparatively lower damage. These findings highlight the need for district-specific integrated pest management (IPM) strategies, particularly in Kathmandu, where enhanced monitoring, early detection, and timely implementation of sustainable control measures could help reduce FAW infestations and minimize yield losses.

3.10 Fall armyworm damage severity in relation to temperature

Figure 10 illustrates the relationship between mean damage scores and mean temperatures across different week intervals from May 27th to July 29th in Lalitpur district. Throughout the period, mean damage scores exhibit a general upward trend, starting from around 4 at the end of May and gradually increasing to nearly 6 by the end of July. In contrast, the mean temperature, represented by a line plot, remains relatively stable, fluctuating slightly around 25°C in Lalitpur.

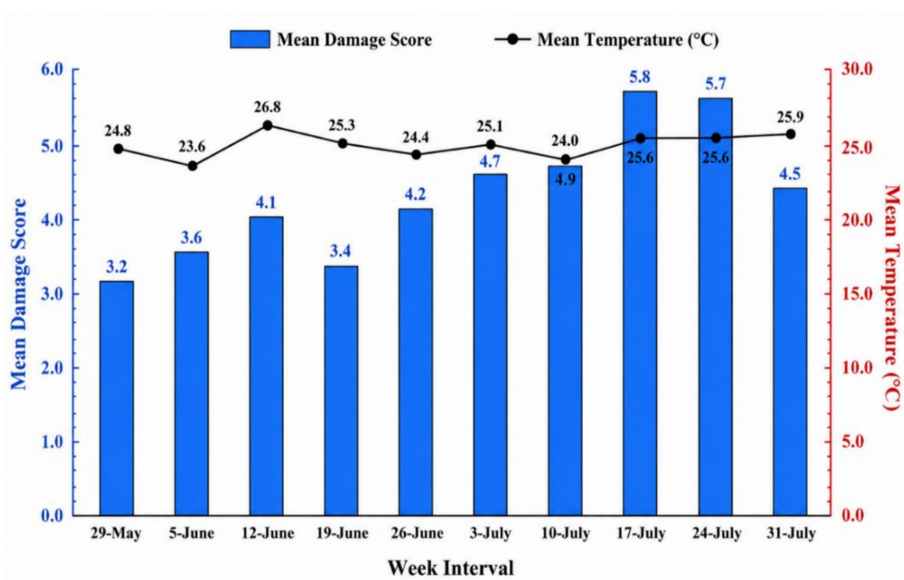

Figure 10. Average damage score vs mean temperature on weekly interval for Lalitpur district

Figure 11 illustrates the relationship between mean damage scores and mean temperatures across different week intervals from May 29th to July 31st in Kathmandu district. Throughout the period, mean damage scores exhibit a general upward trend starting from around 4 from first week of June to gradually increasing to nearly 6 by the last week of July. In contrast, the mean temperature represented by a line plot, have gradual increment in temperature from first week of June at temperature around 25.5°C. Furthermore, the mean temperature fluctuates over time with its value ranging from 20 to 25°C in Kathmandu.

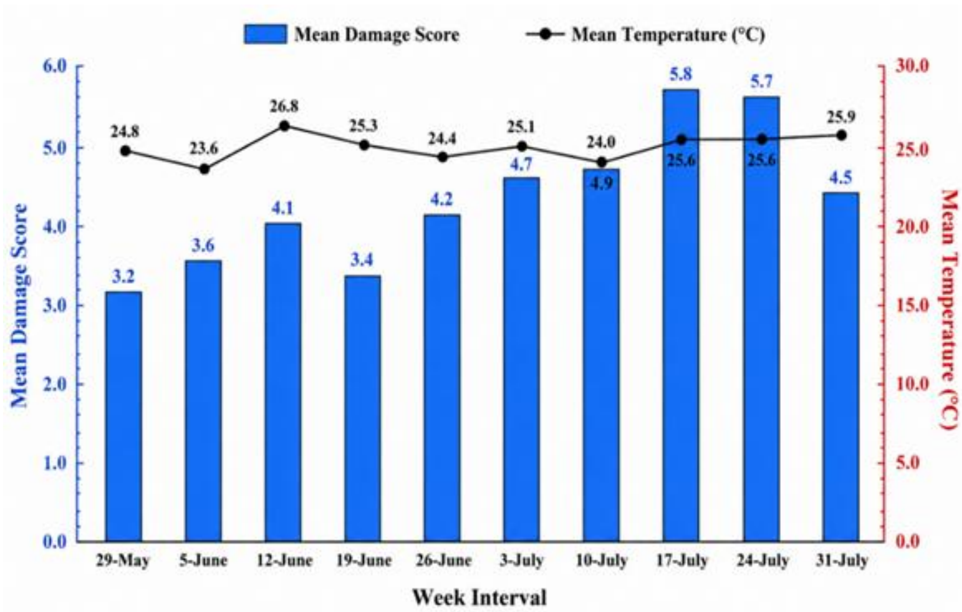

Figure 11- Average damage score vs mean temperature on weekly interval for Kathmandu

Figure 12 illustrates the relationship between mean damage scores and mean temperature across different week intervals from May 27th to July 29th. Throughout the period, the mean field damage scores exhibit alternatively increasing and decreasing trend from end of May to the first week of July. Similarly, the mean damage score exhibits increasing value from start of July and gradually increases in the mid-July and depicts decreasing trend by the end of July. In contrast, the mean temperature represented by a line plot remains relatively stable fluctuating around 25°C in Bhaktapur district.

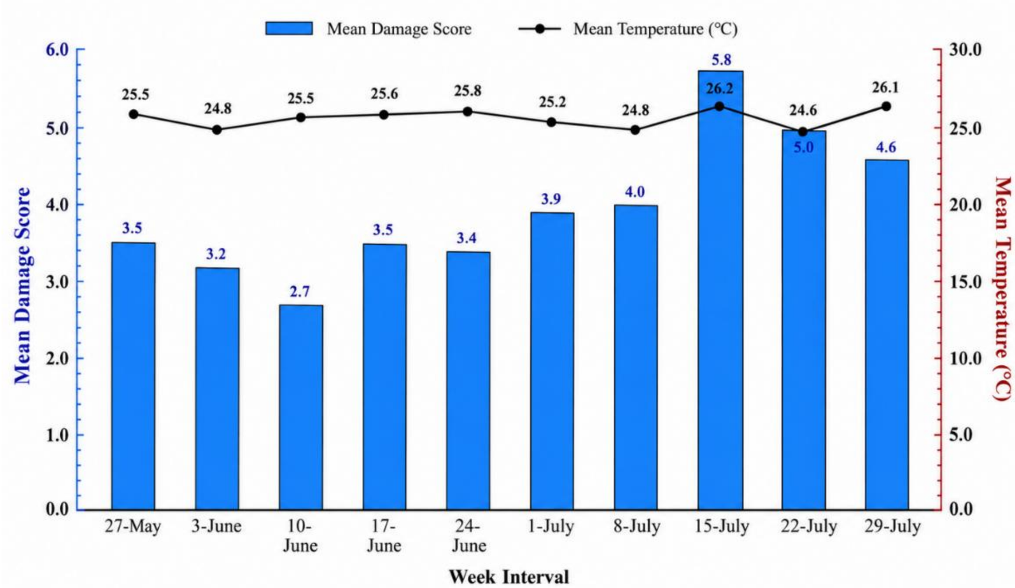

Figure 12. Average damage score vs mean temperature on weekly interval for Bhaktapur

Despite these temperature fluctuations, the increase in damage scores appears consistent, indicating that while temperature may have some influence, other factors are likely contributing to the rising damage. The correlation between damage and temperature stability suggests the need for closer examination of environmental or management practices during this period to better understand the causes of increasing crop damage. In this study, infestation pattern of *S. frugiperda* in relation to temperature remain parallel to the findings of Du Plessis et al. (2020), who reported that larval development is the highest between 26°C and 30°C. The time required for *S. frugiperda* development is significantly shorter at 31°C than it is at lower temperature but lower temperatures are still sufficient for the pest to finish its development stage (Díaz-lvarez et al., 2021). This might be the reason that even at lower temperature of 25 to 26°C infestation level is high. Likewise, findings of Haroli et al. (2023) concluded maximum temperature positively correlated in rainy season and negatively correlated in summer. Overall, the graph of three districts have an increasing trend in the average damage score level on the month of July due to the fact that low rainfall act as an additive for increase in mean damage score (Haroli et al., 2023). Similarly, He et al. (2019) reported that the mean temperature of 19 to 30 °C was optimal for *S. frugiperda* growth and development, which peaked at 29 °C. This aligns with the findings of the highest average damage score level recorded in Kathmandu and Bhaktapur in relation to temperature.

The analysis of correlation of average temperature on average damage score was conducted across three districts which have been depicted in **Table 6**.

Table 6. Coefficient of determination across three surveyed districts

District	Coefficient of determination (R^2)
Lalitpur	0.203
Kathmandu	0.241
Bhaktapur	0.196

Source: Field research, 2024

The coefficient of determination (R^2) values obtained across the three surveyed districts—Kathmandu (0.241), Lalitpur (0.203), and

Bhaktapur (0.196)—indicate that mean temperature explains approximately 19–25% of the variation in fall armyworm (*Spodoptera frugiperda*) damage in maize. This suggests that while temperature plays a significant role in influencing pest incidence and severity, a large proportion of the variation is governed by other factors.

The relatively moderate R^2 values observed in this study are consistent with previous findings that highlight temperature as an important but not exclusive driver of fall armyworm population dynamics. For instance, Haroli et al. (2023) reported that temperature significantly influences larval development, feeding activity, and infestation intensity, but emphasized that its effect is often moderated by environmental and agronomic conditions. Similarly, Prasanna et al. (2018) and Day et al. (2017) noted that FAW performance is highly sensitive to temperature ranges, with optimal development occurring under warm conditions; however, pest outbreaks are also strongly affected by rainfall patterns, humidity, and host plant availability.

4. CONCLUSION

Fall armyworm is an invasive and destructive pest native to tropical and sub-tropical regions of the world. High infestation level of *S. frugiperda* was in the farms located in Tarakeshwar municipality. The survey conducted to know the perception of the farmers and management practices adopted in the maize growing areas gave a valuable insight about the factors responsible for the *S. frugiperda* damage incidence in those areas. Temperature fluctuation influenced the incidence severity and damage levels in the maize fields. Damage severity level analyzed considering the crop growth stage showed that there was significant effect in the damage levels with respect to the crop growth stages. Knee-height followed by tasseling and silking stage tend to have more damage score levels compared to other late whorl stages of the crop. Similarly, milking and dough stage showed more damage levels in comparison to other stages. Overall, the temperature threshold for *S. frugiperda* incidence severity determined in this study would aid in predicting the distribution and incidence level. Further study about the infestation pattern and damage levels against *S. frugiperda* is imperative.

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