Research Article:

EVALUATING MAIZE VARIETAL SUSCEPTIBILITY AND INSECTICIDE EFFICACY AGAINST FALL ARMYWORM

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ABSTRACT

The fall armyworm (FAW), *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae), is one of the most destructive polyphagous pests, causing significant reductions in maize yield as its larvae feed on developing maize leaves and cobs. Field experiments were conducted to assess the extent of damage and yield loss caused by fall armyworm infestation in maize, following a randomized complete block design with three replications at the National Maize Research Program in Rampur, Chitwan, Nepal, during the spring season of 2023. Maize varieties such as Rampur Hybrid (RH)-10, RH-12, RH-4, RH-6, TX-369, Arun-2, ZM-401, ZM-627, BGBY POP, and Rampur Composite were used as test varieties (first factor). Pest control conditions (spray and non-spray) served as the second factor. Spray plots were treated with spinosad 45% EC, while non-spray plots received only water spray. Both were applied at 10-day intervals from the V4 stage of maize. Arun-2 was the most susceptible to fall armyworm damage, resulting in a higher pest infestation. Meanwhile, RH-12 exhibited a lower plant infestation. Quantitative yield loss increased with fall armyworm infestation, ranging from 5.54% to 34.48% across maize varieties. The highest yield loss was observed in the open-pollinated variety: Arun-2 (34.48%), followed by ZM-627 (20.73%) and BGBY POP (14.85%). The lowest yield loss of 5.54% occurred in RH-12. Application of spinosad 45% EC to RH-12 resulted in increased yield and reduced susceptibility to fall armyworm. These findings suggest that cultivating relatively tolerant maize varieties such as RH-12, combined with appropriate insecticide application, can reduce fall armyworm infestation and yield loss, thereby improving maize productivity and supporting sustainable pest management strategies.

Keywords: Damage, infestation, spinosad, *Spodoptera frugiperda*, sustainable, yield loss

INTRODUCTION

Maize, *Zea mays* L. (Poaceae), is one of the most prominent cereal crops produced worldwide, possessing the highest genetic yield potential among cereals (Shiferaw et al., 2011) and is thus considered a miracle crop (Singh et al., 2018). In Nepal, maize ranks as the second most important cereal crop, covering 916,044 hectares with a total yield of 3,193,869 metric tons and a productivity of 3.49 metric tons per hectare (MoALD, 2025). Nonetheless, various factors such as weather conditions, diseases, weeds, and insect pests at different growth stages from sowing to maturity seriously limit the full realization of maize's yield potential across seasons (Assefa & Ayalew, 2019). The list of arthropod species that feed on the maize crop at various stages of growth ranges from 130-250 species (Sarup et al., 1977; Mathur, 1992). Furthermore, Siddiqui and Marwaha (1994) reported that among the numerous insect species associated with maize, only about a dozen insect pests are highly destructive, causing varying degrees of damage from sowing to harvest, and therefore requiring targeted control measures.

The fall armyworm, *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae), originally inhabits tropical and subtropical regions of America (Capinera, 2002) and is a destructive insect affecting maize in many parts of the world (Sharanabasappa et al., 2018). In Nepal, this pest was first observed in Gaidakot, Nawalpur district, on May 9, 2019 (Bajracharya et al., 2019). It has spread to over 72 districts of Nepal, causing a loss of 20-35% (PQPMC, 2019). The fall armyworm is an invasive, polyphagous pest that is highly destructive, with more than 350 host plants across 76 plant families (Montezano et al., 2018). However, it prefers maize and sweetcorn (CABI, 2019; Hoy, 2013; Montezano et al., 2018). The larval stage feeds on growing maize leaves, creating elongated, papery windows, and then moves to the whorl, with moist, sawdust-like frass near the funnel and upper leaves (CABI, 2017). The polyphagous nature of fall armyworm enables the larvae to easily find suitable hosts during their dispersal (Rojas et al., 2018).

Crop productivity is limited by biotic factors (insects, diseases, and weeds) and abiotic factors (temperature, moisture, and wind), which can reduce both yield quantity and quality, leading to economic losses. Continuous screening of available maize genotypes is essential for developing fall armyworm-tolerant maize varieties through resistance breeding (Kasoma et al., 2020). Identifying new sources of maize genotypes resistant to various insect pests can help researchers further explore host-plant resistance in maize (Asare et al., 2023). Host plant resistance (HPR) is a vital component of integrated pest management (IPM), offering a dependable, safe, cost-effective, environmentally friendly, and easily adoptable method for controlling fall armyworm (Prasanna et al., 2018; Prasanna et al., 2022; Sharma & Ortiz, 2002).

To mitigate overreliance on insecticides and reduce the environmental impacts of hazardous synthetic chemicals, integrated pest management (IPM) strategies for fall armyworm increasingly emphasize bio-rational compounds such as spinosad, spinetoram, chlorantraniliprole, and the botanical insecticide azadirachtin, with spinosad showing the highest and most rapid larval mortality rates (Cook et al., 2004; Adhikari et al., 2024). Spinosad was developed from the soil bacterium *Saccharopolyspora spinosa*, and its active component, spinosyn, acts on the nicotinic acetylcholine receptor of the insect (Thompson et al., 2000). Moreover, integrating insect-resistant maize hybrids with targeted, low-risk insecticides reduces dependence on costly broad-spectrum chemicals and enhances farmer adoption due to practical field advantages (Varma et al., 2022). Minimizing the use of highly hazardous insecticides is therefore a critical priority for sustainable agriculture. Consequently, this study aimed to assess fall armyworm damage and associated yield loss among different maize varieties and to evaluate the effectiveness of spinosad as a safe bio-rational insecticide for managing fall armyworm infestation.

RESEARCH METHODS

Study area

Field experiments were conducted during the spring season of 2023 at the National Maize Research Program (NMRP) in Rampur, Chitwan, Nepal. The experimental site was located at 27° 40' N latitude and 84° 9' E longitude, at an altitude of 228 m above sea level. The area has a humid and subtropical climate, characterized by cool winters and hot summers. The soil of the study field is generally acidic (pH 4.6-5.7), light-textured, and classified as sandy loam. The site receives an average annual rainfall of 2215.30 mm, of which more than 75% occurs during the monsoon season from mid-June to mid-September (Adhikari et al., 2024).

Study design, layout, and treatment details

The experiment was laid out using a two-factor Randomized Complete Block Design with three replications. The maize varieties evaluated in the experiment were: TX-369, RH-10, RH-12, RH-4, RH-6, Arun-2, ZM-401, Rampur Composite, BGBY POP, and ZM-627, which constituted the first experimental factor. The second factor comprised pest management conditions, namely, sprayed and non-sprayed plots. The sprayed (protected) plots were maintained through three applications of a standard insecticide, Tracer (spinosad 45% SC), produced by Corteva Agriscience, applied at a rate of 0.3 ml/L at ten-day intervals. The recommended dose of the liquid treatment was mixed with water in a 2-liter hand sprayer and then sprayed onto the maize plants. The first spray was initiated when a sufficient infestation (25-30% on average) was observed, coinciding with the crop being 24 days old (V4 stage). Conversely, the non-sprayed plots (unprotected plots) were subjected to natural infestation by fall armyworm. The plot size consisted of four rows, each 5 m long, with a spacing of 60 cm between rows and 20 cm between plants. To minimize insecticide drift between treated and untreated plots, the sprayed and non-sprayed treatments were maintained in two separate blocks with buffer rows, alley spaces, and additional border plants between plots. Insecticide applications were carried out during calm weather conditions using a hand sprayer with coarse droplet application to reduce spray movement, and observations were recorded only from the central rows to avoid border effects and possible contamination. All maize varieties were obtained from the National Maize Research Program (NMRP) in Rampur, Chitwan, Nepal. The recommended fertilizer dose for an open-pollinated maize variety was 120:60:40 NPK kg/ha, whereas for a hybrid maize variety, it was 180:60:40 NPK kg/ha, supplemented with farmyard manure at 10 t/ha and a seed rate of 20 kg/ha (AITC, 2024). All other standard agronomic practices were followed as per the recommended guidelines for maize cultivation.

Observation parameters

Observations were recorded on the number of live larvae of fall armyworm, plant infestation percentage before the tasseling stage, thousand-grain weight (g), and grain yield (kg/ha). Meteorological data were gathered from the weather station located at the National Maize Research Program in Rampur, Chitwan. The percentage of plant infestation was determined based on the number of infested plants compared to the total number of plants in the stand. The maize grain yield was recorded from the inner four rows of each treatment. Grain yield at 15% moisture content was calculated based on the fresh ear weight, following the formula established by Carangal et al. (1971) and Shrestha et al. (2021). The percentage reduction in unprotected plots due to insect damage parameters was calculated, and the corresponding losses in maize grain yield were assessed. The formulae used for this study are presented below:

- $\text{Maize plant infestation percentage (\%)} = \frac{\text{Number of infested plants}}{\text{Total number of plants stand}} \times 100\%$

- $\text{Maize grain yield (kg/ha)} = \frac{\text{F.W.(kg/plot)} \times (100 - \text{HMP}) \times \text{S} \times 10000}{(100 - \text{DMP}) \times \text{NPA}}$

where,
F.W. = Fresh weight of ear in kg per plot at harvest
HMP = Grain moisture percentage at harvest
DMP = Desired moisture percentage, i.e., 15%
NPA = Net harvest plot area, m^2
S = Shelling coefficient, i.e., 0.8

- $\text{Loss in grain yield percentage (\%)} = \frac{\text{X1} - \text{X2}}{\text{X1}} \times 100\%$

where,
X_1 = Grain yield obtained from protected plots
X_2 = Grain yield obtained from unprotected plots

Statistical analysis

The collected data were systematically tabulated and organized in Microsoft Excel before statistical analysis. Before analysis, the data were examined for accuracy, homogeneity, and normality assumptions using the Global Validation of Linear Model Assumptions (GVLMA) test in R Studio. Variables that did not meet the assumptions of normal distribution were subjected to a square root transformation to stabilize variance and improve data normality. The transformed data were then analyzed using analysis of variance (ANOVA) in R Studio version 4.1.3 with the aid of the agricolae package. Treatment means were separated and compared using the Least Significant Difference (LSD) test at the 5% level of significance following the procedure described by Gomez and Gomez (1984). Unless otherwise stated, statistical significance was determined at $p \leq 0.05$, and graphical presentations were prepared using the analyzed mean values.

The relationship between fall armyworm infestation and grain yield was assessed using Pearson's correlation and simple linear regression analyses. The mean number of FAW larvae per plant was considered the independent variable (X), while grain yield (mt/ha) was the dependent variable (Y). The correlation coefficient (r), coefficient of determination (R^2), and regression equation were calculated to quantify the effect of FAW infestation on grain yield. Statistical analyses were conducted using a Microsoft Excel sheet.

RESULTS

Effect of maize varieties on FAW infestation and grain yield

In the 2023 spring season, significant variations were observed among maize varieties in terms of fall armyworm infestation, thousand-grain weight (g), and grain yield (kg/ha) (Table 1). This indicates that varietal characteristics strongly influenced the susceptibility of maize to FAW damage and its yield performance under field conditions.

Among the tested varieties, RH-12 recorded the lowest plant infestation (17.91%), which was statistically similar to Rampur Hybrid-4 (20.22%), ZM-401 (21.13%), and TX-369 (21.19%). The reduced infestation in RH-12 may indicate the presence of tolerant or resistant traits against FAW. In contrast, the highest infestation levels were recorded in the varieties BGBY POP (27.89%) and Arun-2 (27.37%), which were significantly comparable to ZM-627 (25.59%), Rampur Hybrid-6 (23.74%), Rampur Composite (23.33%), and Rampur Hybrid-10 (23.04%), suggesting their susceptibility to FAW infestation.

Thousand-grain weight (TGW) also differed significantly among varieties. The highest TGW was recorded in RH-12 (386.83 g), which was statistically at par with RH-6 (383.17 g), RH-10 (383.00 g), RH-4 (377.00 g), and TX-369 (371.33 g). Conversely, the lowest TGW was found in Arun-2 (324.50 g), indicating poor grain development likely associated with higher pest damage and lower genetic yield potential.

Similarly, grain yield varied significantly among the varieties. RH-12 produced the highest grain yield (8420.66 kg/ha), followed by TX-369 (8035.37 kg/ha), RH-4 (8032.11 kg/ha), RH-6 (7891.81 kg/ha), and RH-10 (7739.70 kg/ha), which were statistically similar. In contrast, the lowest grain yield was recorded in ZM-627 (3462.47 kg/ha), which was statistically comparable to Arun-2 (3863.85 kg/ha) (Table 1). The superior performance of RH-12 may be attributed to its lower FAW infestation and higher grain weight.

Overall, the findings suggest that maize varieties differed considerably in their response to FAW infestation and yield performance. Hybrid varieties, particularly RH-12, exhibited better tolerance and productivity compared to open-pollinated varieties and composites under FAW pressure.

Effect of spinosad application on FAW infestation and grain yield

Pest control conditions significantly influenced FAW infestation, thousand-grain weight, and grain yield. Application of spinosad 45% SC effectively reduced FAW infestation and improved yield attributes compared to non-sprayed conditions. The sprayed plots recorded significantly lower plant infestation (18.26%) than the non-sprayed plots (28.02%). This substantial reduction in infestation demonstrates the effectiveness of spinosad in suppressing FAW populations under field conditions. Likewise, spinosad application significantly improved thousand-grain weight. The sprayed treatment produced a TGW of 379.93 g, whereas non-sprayed plots recorded only 346.53 g. The increase in grain weight in sprayed plots could be due to reduced leaf and whorl damage, which allowed better photosynthetic activity and grain filling.

Similarly, grain yield was also significantly influenced by insecticide application. Sprayed plots yielded 6668.22 kg/ha, which was significantly higher than the yield obtained from non-sprayed plots (5923.84 kg/ha). The increase in yield under sprayed conditions indicates that effective FAW management through spinosad minimized crop damage and enhanced productivity. Therefore, the results confirm that spinosad application was effective in reducing FAW infestation and improving yield and yield-attributing characters of maize.

Interaction effect of maize varieties and pest control conditions (sprayed and non-sprayed)

The interaction effect between maize varieties and pest control conditions was significant for plant infestation, but non-significant for thousand grain weight (P = 0.403) and grain yield (P=0.858). This suggests that the response of maize varieties to spinosad application differed mainly in terms of FAW infestation, while yield-related traits were comparatively stable across treatments.

Among the interaction combinations, the lowest plant infestation was observed in RH-12 under the sprayed condition (10.62%), followed by TX-369 (11.88%), RH-4 (14.67%), and RH-10 (15.93%). These results indicate that insecticide application was particularly effective in reducing FAW infestation in these hybrid varieties. In contrast, the highest infestation in non-sprayed plots occurred in BGBY POP (31.93%) and Arun-2 (31.91%), which were statistically similar. This demonstrates that susceptible varieties experienced severe FAW damage when no insecticide protection was provided.

Although the interaction effect on grain yield was statistically non-significant, numerical differences were observed among treatment combinations. Grain yield under sprayed conditions was the highest in RH-12 (8663.42 kg/ha), followed by RH-4 (8596.57 kg/ha) and TX-369 (8314.94 kg/ha). The higher yields in these combinations may be associated with lower infestation and better grain development under protected conditions. The lowest yields were recorded in Arun-2 (4666.40 kg/ha) and ZM-627 (3860.09 kg/ha) under non-sprayed conditions.

Overall, the interaction analysis revealed that spinosad application substantially reduced FAW infestation across maize varieties, with hybrid varieties showing better protection and productivity than susceptible open-pollinated varieties under both sprayed and non-sprayed conditions.

Table 1. Effect of insecticide (spinosad @ 0.3 ml/L of water) spray and non-spray in different maize varieties infested by fall armyworm at Rampur, Chitwan, Nepal, 2023

Treatments	Plant infestation (%)	Thousand grain weight (g)	Grain yield (kg/ha)
Varieties			
TX-369	21.19[bcd]	371.33[ab]	8035.37[a]
Rampur Hybrid-10	23.04[abc]	383.00[a]	7739.70[a]
Rampur Hybrid-12	17.91[d]	386.83[a]	8420.66[a]
Rampur Hybrid-4	20.22[cd]	377.00[a]	8032.11[a]
Rampur Hybrid-6	23.74[abc]	383.17[a]	7891.81[a]
Arun-2	27.37[a]	324.50[d]	3863.85[de]
ZM-401	21.13[bcd]	356.67[bc]	6296.37[b]
Rampur Composite	23.33[abc]	355.67[bc]	4792.78[c]
BGBY POP	27.89[a]	341.17[cd]	4425.16[cd]
ZM-627	25.59[ab]	353.00[bc]	3462.47[e]
SEm (±)	1.51	6.73	268.42
p-value	<0.001	<0.001	<0.001
LSD (5%)	4.32	19.27	768.47
Pest Control Conditions (PCC)			
Spray	18.26[b]	379.93[a]	6668.22[a]
Non-spray	28.02[a]	346.53[b]	5923.84[b]
SEm (±)	0.67	3.01	120.04
p-value	<0.001	<0.001	<0.001
LSD (5%)	1.93	8.62	343.67
Varieties (V) × Pest Control Conditions (PCC)			
TX- 369 × S	11.88[hi]	397.00	8314.94
TX- 369 × NS	30.49[ab]	345.67	7755.80
Rampur Hybrid-10 × S	15.93[fghi]	406.33	8152.60
Rampur Hybrid-10 × NS	30.15[ab]	359.67	7326.81
Rampur Hybrid-12 × S	10.62[i]	410.33	8663.42
Rampur Hybrid-12 × NS	25.21[abcd]	363.33	8177.91
Rampur Hybrid-4 × S	14.67[ghi]	399.33	8596.57
Rampur Hybrid-4 × NS	25.78[abcd]	354.67	7467.64
Rampur Hybrid-6 × S	22.89[cde]	398.67	8208.72
Rampur Hybrid-6 × NS	24.58[bcde]	367.67	7574.91
Arun-2 × S	22.83[cde]	335.00	4666.40
Arun-2 × NS	31.91[a]	314.00	3061.29
ZM-401 × S	17.81[efgh]	365.33	6485.37
ZM-401 × NS	24.45[bcde]	348.00	6107.38
Rampur Composite × S	20.07[defg]	363.67	4954.73
Rampur Composite × NS	26.58[abcd]	347.67	4630.82
BGBY POP × S	23.85[bcde]	351.00	4779.32
BGBY POP × NS	31.93[a]	331.33	4071.01
ZM-627 × S	22.09[cdef]	372.67	3860.09
ZM-627 × NS	29.08[abc]	333.33	3064.84
SEm (±)	2.13	9.52	379.60
p-value	0.016	0.403	0.858
LSD (5%)	6.10	27.26	1086.78
Grand mean	23.14	363.23	6296.03
CV %	15.96	4.54	10.44

CV: Coefficient of Variation; SEm: Standard Error of Mean; LSD: Least Significant Difference at 5% significance level; Mean values in columns separated by the same letters are not statistically different by LSD at P≤ 0.05; S: spray; NS: non-spray; kg/ha: kilogram per hectare; g: gram

The graph further revealed varietal differences in susceptibility to FAW infestation. Varieties such as TX-369 and RH-10 maintained relatively higher grain yield with lower larval infestation and reduced yield loss percentage, indicating comparatively better tolerance or resistance to FAW damage. In contrast, varieties such as BGBY POP and Rampur Composite experienced higher larval populations and greater yield losses under unprotected conditions, suggesting higher susceptibility to FAW infestation. The highest yield loss of 34.48 % was observed in the open-pollinated variety Arun-2, followed by ZM-627 (20.73 %) and the variety BGBY POP (14.85 %), while the lowest yield loss of 5.54 % occurred in the commercial maize hybrid RH-12 (Fig. 1).

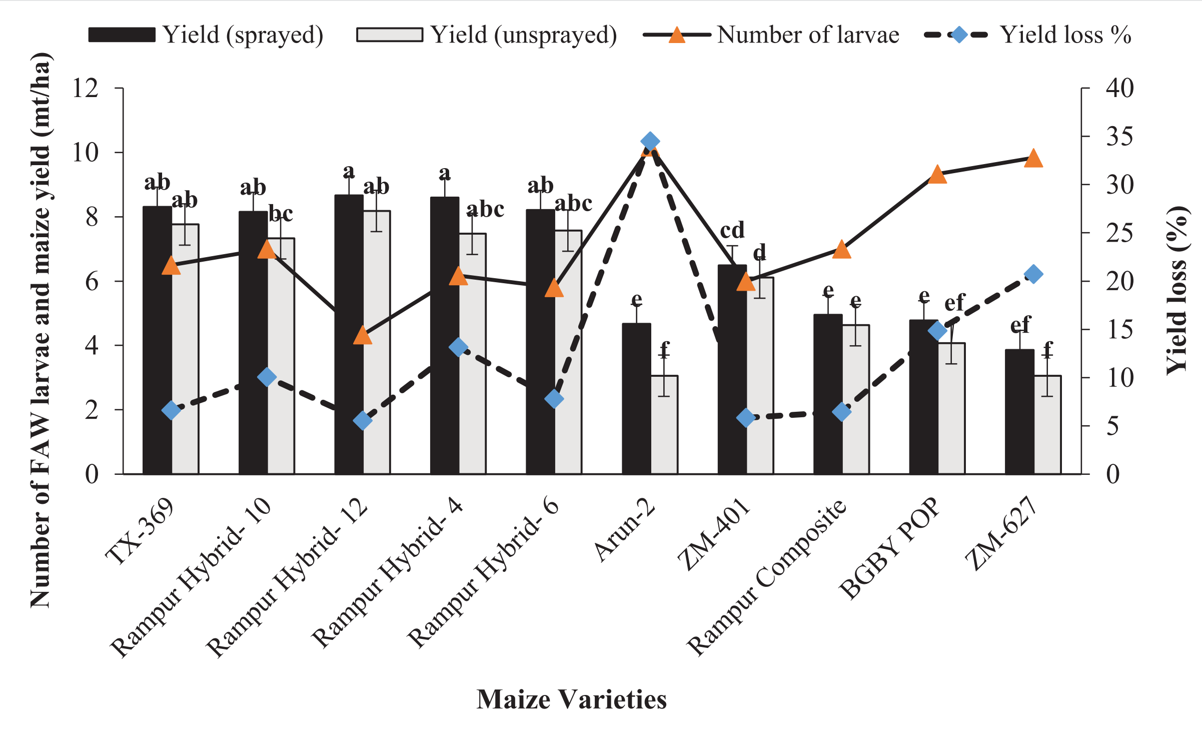

Fig. 1. Relationship between number of FAW larvae, grain yield, and yield loss percentage under sprayed and unsprayed conditions in different maize varieties at Rampur, Chitwan, Nepal, 2023

Correlation and regression analysis between fall armyworm larvae population and maize grain yield

The graph (Fig. 2) clearly demonstrates that maize grain yield declined progressively with increasing FAW larval population in both protected (sprayed) and unprotected (unsprayed) conditions. Under the sprayed condition, the result indicates a strong negative linear relationship between FAW larval density and maize grain yield, described by the equation: $y = -0.8376x + 12.71$, with an R^2 value of 0.7047. The regression slope (-0.8376) suggests that for every additional FAW larva observed per plant, maize grain yield decreased by approximately 0.84 mt/ha. The coefficient of determination ($R^2 = 0.7047$) shows that about 70.47% of the variation in grain yield is explained by differences in fall armyworm larval incidence.

Similarly, the regression equation: $y = -0.9508x + 12.782$, with an R^2 value of 0.8175, shows that the negative regression coefficient confirms that grain yield also decreased significantly with increasing FAW infestation in untreated plots. The negative regression slope indicates that approximately 0.84 mt/ha yield reduction occurred for each unit increase in larval population.

The R^2 value of 81.75% indicates that FAW larval abundance accounted for a considerable proportion of yield variability even without chemical protection (Fig. 2).

The stronger coefficient of determination observed in sprayed plots compared to unsprayed plots suggests that insecticide application reduced the influence of other confounding factors, thereby making the relationship between larval density and yield more consistent. In unsprayed plots, additional environmental and varietal factors may have contributed to yield variability alongside FAW damage.

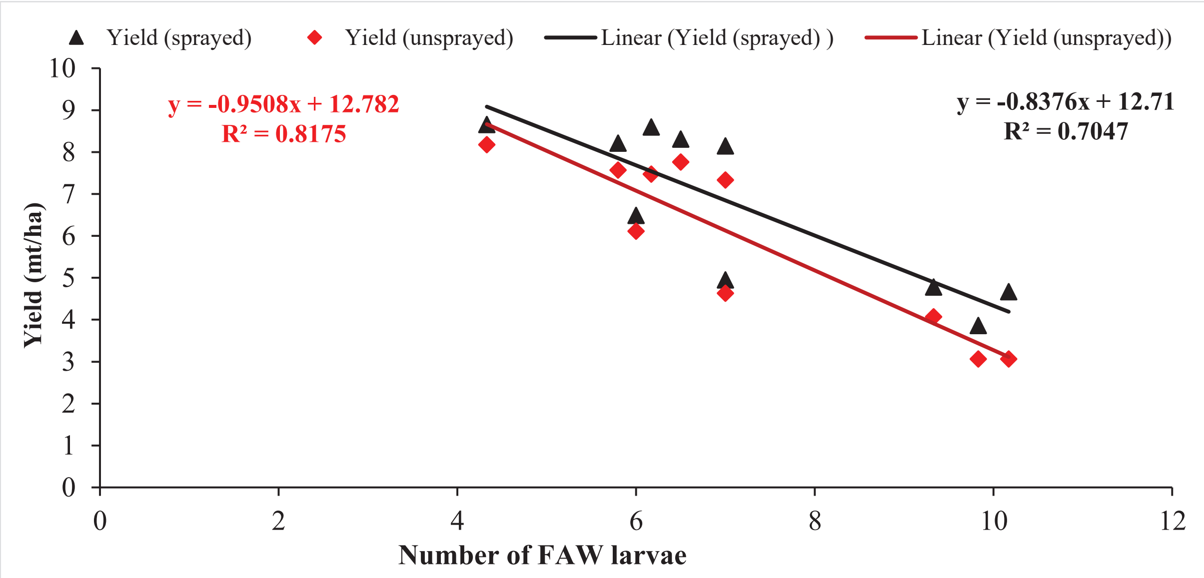

Fig. 2. Relationship between the number of FAW larvae and maize grain yield under sprayed and non-sprayed conditions in Chitwan, Nepal, 2023

DISCUSSION

Host plant resistance is considered one of the most effective and sustainable approaches for managing FAW infestations in maize, alongside the use of improved and genetically enhanced cultivars (Burtet et al., 2017). The present study demonstrated that grain yield losses increased with increasing levels of FAW infestation across maize varieties. Estimated yield losses ranged from 5.54% to 34.48%, with an average loss of 12.55% among the tested genotypes. The highest yield losses were observed in open-pollinated varieties, indicating their greater susceptibility to FAW damage. In contrast, hybrid varieties experienced comparatively lower yield reductions, particularly when protected with insecticide applications. These findings are consistent with previous studies reporting that improved maize hybrids generally exhibit greater tolerance to fall armyworm infestation and maintain higher grain yields under pest pressure (Adhikari et al., 2025; Neupane et al., 2022). Variations in yield loss estimates reported across studies may be attributed to differences in maize genotypes, infestation intensity, environmental conditions, geographical locations, and crop management practices.

The observed differences in FAW infestation and associated yield losses among maize varieties suggest the existence of varying levels of host plant resistance. Based on infestation levels and larval abundance, RH-12 and RH-4 were the least preferred varieties, whereas Arun-2, BGBY POP, and ZM-627 were among the most preferred by FAW. Previous evaluations by the National Maize Research Program (NMRP, 2021) similarly classified maize genotypes according to their susceptibility to fall armyworm, identifying Arun-6 as highly susceptible, Poshilo Makai-1, Rampur Composite, Arun-2, Arun-4, and Manakamana-7 as moderately susceptible, and Manakamana-3, Deuti, and Rampur Hybrid lines as least susceptible. In the present study, hybrid varieties, particularly RH-12, RH-4, and RH-10, consistently exhibited lower infestation levels, reduced foliar damage, fewer larvae per plant, and higher grain yields, further supporting their relative resistance to FAW.

Host plant resistance may be associated with both morphological and biochemical plant traits that influence insect feeding and oviposition behavior. Plant characteristics such as trichome density, epicuticular wax content, leaf thickness, tissue toughness, and the production of secondary metabolites can affect host selection and larval performance (Gatehouse, 2002). Trichomes, in particular, have been reported to play a significant role in reducing feeding damage caused by FAW (Moya-Raygoza, 2016). Tiwari (2022) also suggested that Rampur hybrid varieties possess greater densities of hairs on leaves and stems, which may contribute to their tolerance against fall armyworm. Similarly, RH-12 is characterized by a tight husk covering and the presence of fine hairs on leaves, stems, and cobs, traits that may provide physical barriers against infestation and feeding, thereby contributing to its observed tolerance (Firake et al., 2019). The identification and utilization of resistant maize genotypes are important for breeding programs and can enhance the effectiveness and economic viability of integrated pest management strategies (Anuradha, 2012; Yonow et al., 2017).

The study further revealed that FAW infestation was substantially higher in non-sprayed plots than in plots treated with spinosad. Consequently, grain yield losses were consistently greater under untreated conditions, although the magnitude of loss varied among maize varieties. Across all tested genotypes, spinosad application significantly reduced infestation levels, larval populations, and foliar damage compared with untreated plots. These findings agree with previous reports identifying spinosad as one of the most effective insecticides against FAW, providing rapid larval mortality and effective field control (Cook et al., 2004; Sisay et al., 2019). Similarly, Hardke et al. (2011) and Sharma et al. (2023) reported that spinosad and spinetoram were among the most effective treatments for managing FAW populations. Bajracharya and Bhat (2024) also found that spinosad significantly reduced leaf damage severity, the proportion of damaged plants, and overall damage scores in maize. Supporting these field observations, a laboratory leaf-dip bioassay conducted in Chitwan, Nepal, demonstrated that spinosad, spinetoram, chlorantraniliprole + lambda-cyhalothrin, emamectin benzoate, and chlorantraniliprole achieved 100% larval mortality within 48 hours after treatment application (Adhikari et al., 2024). The reduction in infestation and plant damage observed in treated plots ultimately translated into higher grain yields, corroborating earlier findings that maize fields protected with spinosad or spinetoram produce significantly greater yields than untreated fields (Nonci et al., 2021; Srujana et al., 2021).

Overall, the results indicate substantial variation in susceptibility to FAW among maize varieties, with hybrid genotypes generally exhibiting greater tolerance and lower yield losses than open-pollinated varieties. Although the present findings provide valuable information on varietal responses to fall armyworm infestation, further research involving a broader range of maize genotypes is warranted. Future studies should incorporate additional parameters, such as oviposition preference, larval development, plant growth characteristics, and resistance mechanisms, to provide a more comprehensive understanding of host plant resistance and to support the development of sustainable FAW management strategies.

CONCLUSION

The FAW has become a highly destructive insect pest affecting maize crops across all maize-growing regions of Nepal. The present study demonstrates that effective management can be achieved through the application of spinosad, particularly in hybrid maize varieties. The results indicate that varietal differences play a major role in determining fall armyworm infestation levels and maize yield performance. Among the tested varieties, RH-12, TX-369, RH-10, and RH-4 exhibited relatively better tolerance and superior yield potential, whereas Arun-2, BGBY POP, and ZM-627 were more susceptible to fall armyworm damage. Furthermore, the application of spinosad significantly reduced infestation and improved yield and yield attributes, highlighting its potential as an effective, eco-friendly pest management option. Moreover, the interaction effects suggest that the benefit of spinosad spray was more pronounced in tolerant varieties, while susceptible varieties like Arun-2 and ZM-627 remained low-yielding even under spray conditions. The findings of this study offer practical insights for maize farmers in selecting fall armyworm-tolerant varieties and highlight the importance of integrating safe, biorational insecticides like spinosad into integrated pest management (IPM) strategies.

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AUTHOR CONTRIBUTIONS

CA: Conceptualization, Methodology, Investigation, Writing – original draft; **ST:** Conceptualization, Data curation, Writing – review & editing, Supervision; **RBT:** Investigation, Writing – review & editing; **SN:** Resources, Writing – review & editing.

CONFLICT OF INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

ETHICAL APPROVAL AND PERMITS

Not applicable.

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