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Screening of lowland maize and sorghum genotypes for resistance to fall armyworm, Spodoptera frugiperda (J. E. Smith) (Lepidoptera: Noctuidae) in the central part rift valley of Ethiopia

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Abstract

The fall armyworm (*Spodoptera frugiperda* Smith) (Lepidoptera: Noctuidae) is native to the tropical and subtropical regions of the Americas and is recognised as a highly invasive and polyphagous pest. This species was first identified outside its native range in central and western Africa in early 2016, and it made its entrance in Ethiopia in late 2017, initially impacting the southern regions before rapidly spreading throughout the country. The fall armyworm has caused significant damage to maize and sorghum crops, prompting farmers to turn to expensive chemical treatments. However, the ongoing reliance on these chemicals is unsustainable, as they are often inaccessible and unaffordable for small-scale farmers. In response, host plant resistance has emerged as a viable alternative within an integrated pest management framework. A screening of approximately 55 maize genotypes and 50 sorghum genotypes was conducted to assess their resistance to the fall armyworm, both in controlled lath house conditions and in field settings. Results showed that eight maize genotypes, DLF005, DLF026(3.47), DLF042(3.5), DLF175, DLF192(3.69), DLF213(3.88), DLF2423007(3.78), and DLF2423012 (4.37), consistently exhibited lower levels of leaf damage from the pest in both environments. Similarly, seven sorghum genotypes—ETSC19048-4-7(4.29), ETSC17488-50-3(4.33), ETSC19161-5-12(4.92), ETSC19181-12-7(4.15), ETSC19125-12-4(4.11), ETSC19142-17-4(4.23), and ETSC19145-8-8(3.96)—demonstrated significantly reduced damage compared to other tested lines across both experimental setups. These resistant lines should be incorporated into breeding programs aimed at enhancing the genetic resilience of crops against fall armyworm infestations. However, further investigations are needed to better understand the resistance mechanisms present in each genotype.

1. Introduction

Spodoptera frugiperda (Lepidoptera: Noctuidae), hereafter referred to as FAW, is an invasive insect pest native to the tropical and subtropical regions of the Americas (Sisodiya et al. 2018). *S. frugiperda is* widely distributed in the Americas, occurring from South Central to Eastern Canada, coast to coast in the United States, south to Argentina, and throughout the Caribbean (*Ganiger* et al. *2018*). Native to the Americas, it has recently emerged as a serious global agricultural threat. *FAW* was first reported in Africa in late January 2016 and is now present in areas where cereal crops, particularly maize and sorghum, are produced (Montezano et al. 2018).

S. frugiperda is a highly destructive, polyphagous pest known for its ability to feed on a wide variety of plant species. The larvae are capable of feeding on more than 100 plant species, including key staple and commercial crops such as maize, rice, sorghum, millet, sugarcane, various vegetables, and cotton. These feeding habits result in considerable damage and substantial yield losses across affected regions. Recent research has expanded our understanding of the pest's host range. Montezano et al. (2018) documented an alarming total of 353 plant species identified as fall armyworm hosts in the Americas, spanning 76 plant families. The majority of these belong to Poaceae (106 species), Asteraceae (31 species), and Fabaceae (31 species), indicating the pest's strong preference for cereal and leguminous crops.

S. frugiperda was first officially reported in Africa in 2016 (Goergen et al. 2016), and it has since become one of the most devastating invasive species on the continent. Its rapid spread and adaptability have allowed it to establish populations in virtually all agroecological zones across Sub-Saharan Africa (SSA). The pest poses significant risks to key African crops, particularly maize, sorghum, millet, and various legumes (Overton et al. 2021). Economic assessments indicate that crops worth over USD 13 billion annually are at risk due to fall armyworm infestations in SSA (Harrison et al. 2019). For maize alone, Africa's primary staple food, yield losses have been reported to range between 11% and 58%, leading to estimated economic losses of up to USD 9.4 billion per year (Harrison et al. 2019). These losses disproportionately affect smallholder farmers, who often operate with limited resources, minimal access to pest management technologies, and insufficient knowledge of invasive species control. For many of these farmers, yield declines translate directly into lost income and increased food insecurity, compounding the challenges of poverty and hunger. Effective management of fall armyworm in SSA is thus not only an agronomic challenge but also a socio-economic and developmental imperative. There is an urgent need for integrated pest management (IPM) strategies tailored to local farming contexts, along with increased investment in farmer education, early warning systems, and access to sustainable control measures.

In Ethiopia, *S. frugiperda* has caused significant disruptions to maize and sorghum production, a staple crop critical to national food security and rural livelihoods. A recent study that integrated agroecology-based community surveys with nationally representative agricultural household data estimated an alarming average annual loss of 36% in maize yields from 2017 to 2019. This translated to a combined reduction of approximately 0.67 million tons of maize and sorghum, or about 0.225 million tons per year (Abro 2021). These losses underscore the severity of *S. frugiperda* infestations and their far-reaching implications for food availability, income security, and national grain reserves. Since the pest's arrival, its control has largely depended on the use of synthetic chemical insecticides. While these chemicals can offer short-term relief, they pose significant environmental and human health risks. The indiscriminate and

repeated application of hazardous pesticides has been linked to the contamination of soil and water bodies, the decline of beneficial insects (such as pollinators and natural enemies), and the development of insecticide-resistant *S. frugiperda* populations (Mendes et al. 2011). These consequences not only undermine long-term pest control efforts but also increase production costs and health risks for farming communities.

This situation underscores the urgent need for alternative, eco-friendly, and affordable pest management strategies. One promising approach is host plant resistance (HPR), which involves developing crop varieties that are naturally less susceptible to pests. HPR has been studied as an effective method for managing *S. frugiperda* in maize. It offers a low-cost, farmer-friendly solution that reduces chemical use, minimizes environmental impact, and can be integrated with other pest control methods, enhancing the effectiveness of integrated pest management (IPM) systems (Mendes et al. 2011). In the invaded SSA, conventional maize breeding for host resistance to *S. frugiperda* has been initiated by international centres like CIMMYT and IITA since the invasion of *S. frugiperda*. Besides international centres, a lot of NARSs in SSA countries (especially in Zambia, Kenya, and Ethiopia) have also been screened for several maize cultivars and found significant variation among them in their preference by *S. frugiperda*. However, limited progress has been made on developing maize and sorghum inbred lines showing resistance to *S. frugiperda* in Ethiopia.

Investing in the development, promotion, and dissemination of resistant maize and sorghum varieties tailored to diverse agroecological zones in Ethiopia represents a critical step toward sustainable FAW management. Coupled with farmer education, participatory breeding programs, and supportive agricultural policies, HPR can play a central role in building the resilience of smallholder farming systems against invasive pests.

1.1 Specific objective:

- To identify maize and sorghum genotypes that are relatively resistance or tolerant to *S. frugiperda*.

2. Materials and Methods

2.1. Experimental Site

The study was conducted at the Melkassa Agricultural Research Centre (MARC), a branch of the Ethiopian Institute of Agricultural Research (EIAR). MARC is geographically positioned at 8°24'N latitude and 39°21'E longitude, at an elevation of 1,550 meters above sea level. It is located approximately 107 kilometres southeast of Addis Ababa and 17 kilometres from the town of Adama, along the highway to Asella. The centre experiences a semi-arid climate, making it particularly suitable for research on drought-tolerant crops such as maize and sorghum.

2.2. S. frugiperda colony establishment and lath house experimental procedures

S. frugiperda eggs were collected from a maize field free of chemical sprays to ensure natural infestation. Egg masses were placed in transparent white plastic boxes (19.00 cm × 12.50 cm × 7.50 cm). Upon hatching, larvae were fed continuously with fresh, chopped maize leaves (variety: *Melkassa 2*) for maize experiments, and sorghum leaves (variety: *Melkam*) for sorghum experiments, according to their developmental stage. Larvae were transferred daily to new boxes of the same size, using a fine camel-hair brush to minimize injury. After pupation, emerging adults were placed in adult rearing cages and provided with a 10% honey solution on cotton swabs. Blotting paper strips were used as oviposition substrates. Eggs laid on the same day were collected and incubated separately to obtain larvae of uniform age. For infestation, neonate larvae (first instar) were manually applied to maize plants at the 3–5 leaf stage using a camel hair brush, following the method by Tefera et al. (2011). The infestation rate was 10 neonates per plant, as per the protocols of Davis et al. (1996) and Prasanna et al. (2018). To minimize cannibalism, larvae were distributed across different nodes of each plant. Infestation was conducted late in the afternoon (4:00–5:00 PM) to prevent larval desiccation under direct sunlight.

2.3. Lath house evaluation

Lath house trials were conducted separately for maize and sorghum from February to April 2022 at MARC. Two lath houses were used: one measuring 30 m × 30 m for the sorghum trial and the other 40 m × 50 m for the maize trial. A total of 55 maize genotypes and 50 sorghum genotypes were evaluated. These genotypes were obtained from the Maize and Sorghum Research Departments at MARC. Plastic pots were obtained from the local market and used for the experiment. Each pot was filled with a soil mixture comprising topsoil, compost, and sand in a 2:1:1 ratio, respectively, up to 15 cm below the pot rim. Before planting, the soil was solarized for 10

days by covering it with black polyethene sheets to reduce soil-borne pathogens and pests. The pots were arranged in a Completely Randomized Design (CRD) with four replications. Two seeds were sown per pot and later thinned to one seedling per pot at the 2–3 leaf stage. Ten days after seedling emergence, artificial infestation was carried out by introducing 10 larvae per plant, following the procedure described by Davis et al. (1996). Data collection began 10 days after artificial infestation.

2.4. Field experiment and data collection

Field experiments were conducted at the Melkassa Agricultural Research Centre from February to May 2023. In these field experiments, a total of 15 selected maize genotypes and 17 sorghum genotypes, which had shown resistance under lath house trials, were evaluated. Each genotype was planted in a single 2-meter row with 75 cm between rows and 25 cm between plants within rows. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The assessment was focused on their efficacy against *S. frugiperda* at various growth stages. FAW damage severity was assessed at multiple stages using a 0–9 rating scale adapted from Davis et al. (1992) and Williams and Davies (2002), where: 0 = No visible damage (Highly resistant), 1 = Pinholes on leaves (Highly resistant), 2 = Pinholes and shot holes (Resistant), 3 = Small lesions (5–10 mm) on 1–3 leaves (Resistant), 4 = Medium lesions (10–30 mm) on 4–7 leaves(Moderately resistant), 5 = Large lesions (> 30 mm) or minor defoliation on 3–5 leaves (Moderately resistant), 6 = Large lesions with significant defoliation on 3–5 leaves (Susceptible), 7 = Lesions > 30 mm with ~ 50% leaf damage (Susceptible), 8 = Lesions > 30 mm with ~ 70% leaf damage (Highly susceptible) and 9 = Complete defoliation (Highly susceptible). Damage ratings were recorded every 10 days starting from 10 days after seedling emergence and continued until the flowering stage.

2.5. Statistical analysis

The *S. ferudiperda* damage severity data related to the screening of maize and sorghum genotypes were analyzed using analysis of variance (PROC GLM) by employing SAS statistical software. Where significant differences exist, were utilized to separate the mean values.

3. Results

3.1. Screening of maize genotypes for the relative resistance against *S. frugiperda* in the lath house.

Results from the maize screening in the lath house indicated that 20 days after emergence, the highest damage scores (6.00) were recorded for the genotypes DLF200, DLF2423003, and M-1Q, with scores ranging from 5.00 to 6.00. In contrast, other maize genotypes exhibited lower damage scores, ranging from 3.00 to 4.75 (Table 7.1).

At 30 days after emergence, the lowest damage scores were noted for DLF002, DLF005, DLF026, DLF038, DLF042, DLF150, DLF173, DLF175, DLF192, DLF211, DLF213, DLF2423002, DLF2423006, DLF2423007, DLF2423010, DLF2423011, and CML 536, with scores between 3.00 and 4.00. As the days progressed, from 40 to 70 days after emergence, the genotypes DLF002, DLF005, DLF026, DLF038, DLF042, DLF150, DLF173, DLF175, DLF192, DLF211, DLF213, DLF2423002, and DLF2423007 maintained damage scores ranging from 3.00 to 5.00, while other genotypes recorded relatively higher damage scores (5.00 to 8.00). By 80 days after emergence, most genotypes exhibited lower damage scores; however, significantly higher scores (6.00 to 7.00) were observed in DLF169, DLF2423001, DLF2423005, DLF2423006, DLF2423009, DLF2423010, DLF2423011, DLF2423014, Melkassa 3, Melkassa 7, CML395, CML445, CML202, CML547, and Zimline/kat. At 90 days after emergence, all genotypes recorded damage scores below 5.00. The mean damage scores were significantly lower (3.00 to 4.5) for genotypes including DLF002, DLF005, DLF026, DLF038, DLF042, DLF150, DLF173, DLF175, DLF192, DLF211, DLF213, DLF2423002, and DLF2423007, while other maize genotypes showed significantly higher scores (5.00 to 6.50) (Table 7.1).

3.2. Field evaluation of selected maize genotypes for relative resistance to *S. frugiperda*

The ANOVA results showed that damage scores for certain genotypes, including DLF002, DLF038, DLF150, DLF173, DLF211, DLF2423002, and DLF2423015, ranged from 4.25 to 7.50, indicating a moderate level of susceptibility to *S. frugiperda*. The mean damage scores for these genotypes were consistently recorded between 5.90 and 6.28, highlighting their vulnerability. Conversely, we observed significantly lower and more uniform damage scores ($P < 0.05$) in other genotypes, such as DLF005, DLF026, DLF042, DLF175, DLF192, DLF213, DLF2423007, and DLF2423012. These genotypes demonstrated a range of damage scores from 3.75 to 4.75 throughout the growing stages, showcasing their potential as more resilient options against FAW.

The mean damage scores for these resistant genotypes ranged between 3.75 and 4.47 (Table 7. 2). This evaluation underscores the importance of selecting and breeding maize genotypes with enhanced resistance to *S. frugiperda*, which is crucial for improving crop yields and ensuring food security. The identification of resilient genotypes not only contributes to effective pest management strategies but also aids in sustainable agricultural practices.

3.3. Screening of sorghum genotypes for their relative resistance to *S. frugiperda* in the lath

house.

The results indicated significantly lower damage scores ($P < 0.05$) in all genotypes at 20 days after emergence. As the plants aged, damage scores increased to a certain extent. However, the damage scores for genotypes ETSC19048-4-7, ETSC19181-14-8, ETSC17488-50-3, ETSC19048-11-4, ETSC17213-1-3, ETSC19161-5-12, ETSC19181-12-7, ETSC19048-16-8, ETSC19160-6-4, ETSC19125-12-4, ETSC19142-17-4, ETSC19166-8-4, ETSC19145-8-8, ETSC14695-1-2, ETSC17258-3-2, ETSC1915363-1-2, and Melkam remained low, ranging from 3.25 to 4.75 throughout the growth stages In contrast, other genotypes recorded significantly higher damage scores ($P < 0.05$), ranging from 3.25 to 7.50 during the same phases (Table 7.3). At 20 and 30 days after emergence, damage scores for all genotypes were similar, with no significant differences noted. However, by 40 days after emergence, significantly lower damage scores ($P < 0.05$) were observed in the aforementioned genotypes, ranging from 2.75 to 3.75, while other genotypes showed scores between 5.25 and 7.00. For the mentioned genotypes, damage scores did not increase significantly with age, remaining low and showing non-significant differences, ranging from 2.75 to 3.50 at 50, 60, 70, and 80 days. Conversely, other genotypes exhibited significantly higher damage scores ($P < 0.05$), ranging from 6.25 to 7.50.

Beyond 70 days after emergence, damage scores decreased for all genotypes, although minimum scores were still recorded for ETSC19048-4-7, ETSC19181-14-8, ETSC17488-50-3, ETSC19048-11-4, ETSC17213-1-3, ETSC19161-5-12, ETSC19181-12-7, ETSC19048-16-8, ETSC19160-6-4, ETSC19125-12-4, ETSC19142-17-4, ETSC19166-8-4, ETSC19145-8-8, ETSC14695-1-2, ETSC17258-3-2, ETSC1915363-1-2, and Melkam, ranging from 2.75 to 4.00. In contrast, damage scores for the other genotypes remained significantly higher ($P < 0.05$), ranging from 5.25 to 6.00. The mean damage scores for the aforementioned genotypes were significantly lower ($P < 0.05$), ranging from 3.24 to 3.78, while the mean scores for other genotypes were significantly higher, ranging from 5.69 to 6.08 (Table 7. 3).

3.4. Field evaluation of selected sorghum genotypes for their relative resistance to *S. frugiperda*

Based on preliminary results of the lath house experiment, a total of 17 sorghum genotypes were selected for further evaluation under field conditions. The results indicated that significantly lower damage scores ($P < 0.05$) were recorded 20 days after emergence, suggesting that early developmental stages are critical for understanding genotype performance. Notably, there were no significant differences among the genotypes at this initial evaluation point (Table 7.4), indicating a potential uniformity in early resistance mechanisms.

As the evaluation progressed across various time points, 30, 40, 50, 60, 70, 80, and 90 days after emergence, the mean damage scores remained significantly lower ($P < 0.05$) for several genotypes, specifically ETSC19048-4-7, ETSC17488-50-3, ETSC19161-5-12, ETSC19181-12-7, ETSC19125-12-4, ETSC19142-17-4, and ETSC19145-8-8. This sustained performance underscores the potential of these genotypes for long-term pest resistance.

The observed trends can be linked to specific genetic traits known to confer pest resistance in sorghum. For instance, the presence of certain phytochemical compounds, such as tannins and phenolics, has been documented to deter herbivory and reduce damage scores. Additionally, morphological traits like leaf toughness and plant height may also play significant roles in minimizing pest impact by affecting insect feeding behaviour and habitat suitability.

In contrast, significantly higher damage scores ($P < 0.05$) were recorded for the other sorghum genotypes, suggesting susceptibility to pest damage. This disparity highlights the importance of selecting and breeding for resistance traits in sorghum improvement programs, as the genetic basis for resistance not only enhances yield but also promotes sustainable agricultural practices by reducing the need for chemical pest control.

Table 1
Mean damage ratings of *S. frugiperda* infestation on different maize genotypes at various days after emergence under artificial infestation in a lath house during 2022 at Melkassa Agricultural Research Centre, Ethiopia.

No	Genotypes	Mean damage rating (0–9)								Mean
		20DAE	30 DAE	40 DAE	50 DAE	60 DAE	70 DAE	80 DAE	90 DAE	
1	DLF002	4.50^{bc}	3.00^{lm}	4.00^{hi}	5.00^{gh}	5.00^{fg}	4.00^{i}	3.00^{hi}	3.00^{fgh}	3.94^{mno}
2	DLF005	4.00^{def}	3.00^{lm}	3.00^{j}	4.00^{i}	4.00^{h}	2.00^{k}	2.00^{k}	2.00^{ij}	3.00^{q}
3	DLF026	4.75^{bc}	3.00^{lm}	4.00^{hi}	4.75^{hi}	4.00^{h}	3.25j	2.00^{k}	2.00^{ij}	3.47^{p}
4	DLF038	5.00^{b}	2.50^{m}	3.25^{ij}	4.00^{i}	4.00^{h}	2.75^{j}	2.75^{ij}	3.50^{efd}	3.47^{p}
5	DLF042	4.25^{cde}	3.00^{lm}	4.25^{jh}	4.25^{hi}	4.25^{gh}	4.00^{i}	2.25^{jk}	1.75^{j}	3.50^{op}
6	DLF150	4.00^{def}	4.00^{ijk}	4.00^{hi}	5.00^{gh}	5.00^{fg}	4.00^{i}	3.00^{hi}	3.00^{fgh}	4.00^{mn}
7	DLF169	4.00^{def}	8.00^{a}	7.00^{bc}	8.00^{a}	7.00^{bc}	6.00^{e}	7.00^{a}	3.00^{fgh}	6.25^{abc}
8	DLF173	4.00^{def}	3.00^{lm}	5.00^{fg}	4.00^{i}	5.00^{fg}	3.00^{j}	3.00^{hi}	2.00^{ij}	3.62^{nop}
9	DLF175	4.25^{cde}	3.00^{lm}	4.00^{hi}	4.50^{hi}	3.75^{h}	4.00^{i}	2.75^{ij}	2.75^{hg}	3.69^{mnop}
10	DLF176	4.50^{bc}	7.00^{b}	7.25^{ab}	8.00^{a}	8.00^{a}	7.00^{bc}	3.50^{gh}	3.25^{efg}	6.06^{abcde}
11	DLF177	4.00^{def}	6.00^{de}	8.00^{a}	7.00^{bcd}	7.00^{bc}	7.00^{bc}	4.00^{fg}	4.00^{bcd}	5.88^{cdefg}
12	DLF192	4.00^{def}	4.00^{ijk}	5.00^{fg}	3.00^{j}	4.00^{h}	4.00^{i}	3.00^{gh}	3.00^{fgh}	3.75^{mnop}
13	DLF196	4.25^{cde}	6.75^{bc}	6.75^{bc}	7.00^{bcd}	6.25^{ec}	5.25^{f}	4.25^{ef}	3.50^{efd}	5.50^{ghijk}
14	DLF200	6.00a	7.00^{b}	6.00^{de}	8.00^{a}	7.00^{bc}	7.00^{bc}	5.00^{cd}	4.00^{bcd}	6.25^{abc}
15	DLF201	4.00^{def}	6.00^{de}	5.00^{fg}	7.00^{bcd}	8.00^{a}	5.00^{fg}	3.00^{hi}	3.00^{fgh}	5.25^{ikl}
16	DLF211	4.00^{def}	4.00^{ijk}	4.00^{hi}	4.00^{i}	5.00^{fg}	5.00^{fg}	4.00^{fg}	3.00^{fgh}	4.13^{m}
17	DLF212	3.00^{g}	4.50^{fg}	6.00^{de}	7.00^{bcd}	7.00^{bc}	7.00^{bc}	4.25^{ef}	3.25^{efg}	5.25^{ijk}
18	DLF213	4.00^{def}	3.00^{lm}	4.00^{hi}	4.00^{i}	5.00^{fg}	4.00^{i}	4.00^{fg}	3.00^{fgh}	3.88^{mnop}
19	DLF216	4.00^{def}	4.25^{hi}	6.50^{bcde}	8.00^{a}	7.00^{bc}	5.00^{fg}	4.50^{def}	3.50^{efd}	5.35^{hijk}
20	DLF222	4.00^{def}	5.50^{ef}	5.75^{ef}	5.75^{fg}	6.00^{de}	5.00^{fg}	3.25^{hi}	3.75^{ecd}	4.88^{l}
21	DLF2423001	4.00^{def}	5.75^{def}	7.00^{bc}	7.25^{ab}	6.25^{cde}	7.00^{bc}	6.50^{ab}	3.00^{fgh}	5.84^{cdefg}
22	DLF2423002	4.00^{def}	3.00^{lm}	4.00^{hi}	5.00^{gh}	5.00^{fg}	4.00^{i}	5.00^{cd}	3.00^{fgh}	4.13^{m}
23	DLF2423003	6.00^{a}	7.00^{b}	8.00^{a}	8.00^{a}	8.00^{a}	7.00^{bc}	3.00^{hi}	4.00^{bcd}	6.38^{ab}
24	DLF2423004	5.00^{b}	6.00^{de}	7.00^{bc}	7.00^{bcd}	8.00^{a}	5.00^{fg}	4.00^{fg}	3.00^{fgh}	5.63^{egfhij}
25	DLF2423005	3.75^{ef}	5.25^{fg}	6.50^{bcde}	6.75^{bcde}	7.25^{ab}	7.00^{bc}	6.00^{b}	4.00^{bcd}	5.88^{cdefg}
26	DLF2423006	4.00^{def}	4.25^{hi}	6.50^{bcde}	7.00^{bcd}	7.00^{bc}	7.00^{bc}	6.00^{b}	5.00^{a}	5.85^{cdefg}
27	DLF2423007	3.50^{fg}	4.00^{ijk}	4.00^{hi}	4.75^{hi}	4.00^{h}	4.00^{i}	3.00^{hi}	3.00^{fgh}	3.78^{mnop}
28	DLF2423008	4.00^{def}	5.00^{gh}	6.25^{cde}	7.00^{bcd}	7.00^{bc}	7.00^{bc}	5.00^{cd}	5.00^{a}	5.87^{cdefg}

Key: Dae= days after emergence; Means in the same column followed by different letters are significantly different ($p < 0.05$)

No	Genotypes	Mean damage rating (0–9)								Mean
		20DAE	30 DAE	40 DAE	50 DAE	60 DAE	70 DAE	80 DAE	90 DAE	
29	DLF2423009	4.00^{def}	7.00^{b}	8.00^{a}	8.00^{a}	8.00^{a}	7.00^{bc}	7.00^{a}	3.00^{fgh}	6.50^{a}
30	DLF2423010	4.00^{def}	3.50^{kl}	4.50^{gh}	7.00^{bcd}	7.00^{bc}	7.00^{bc}	7.00^{a}	3.00^{fgh}	5.50^{ghijk}
31	DLF2423011	3.00^{g}	4.00^{ijk}	8.00^{a}	7.00^{bcd}	7.00^{bc}	7.00^{bc}	6.00^{b}	3.00^{fgh}	5.63 ^{egfhij}
32	DLF2423012	4.00^{def}	5.50^{ef}	7.00^{bc}	6.25^{def}	6.00^{de}	5.25^{f}	5.25^{c}	4.50^{ab}	5.47^{ghijk}
33	DLF2423013	3.50^{fg}	6.00^{de}	7.00^{bc}	7.25^{ab}	7.00^{bc}	8.00^{a}	4.00^{fg}	3.00^{fgh}	5.72^{defghi}
34	DLF2423014	4.00^{def}	6.00^{de}	7.00^{bc}	7.00^{bcd}	8.00^{a}	7.00^{bc}	7.00^{a}	4.00^{bcd}	6.25^{abc}
35	DLF2423015	5.00^{b}	6.00^{de}	6.25^{cde}	6.75^{bcde}	6.75^{bc}	6.25^{de}	3.00^{hi}	3.00^{fgh}	5.38^{hijk}
36	P# Melkassa1	5.00^{b}	5.00^{gh}	7.25^{ab}	7.50^{ab}	7.00^{bc}	6.25^{de}	4.25^{ef}	3.00^{fgh}	5.72^{defghi}
37	Melkassa 2	5.00^{b}	6.00^{de}	7.00^{bc}	7.00^{bcd}	5.75^{d}	4.25^{hi}	4.75^{cd}	3.00^{fgh}	5.35^{hijk}
38	Melkassa 3	5.00^{b}	6.00^{de}	6.00^{de}	6.00^{ef}	7.00^{bc}	7.00^{bc}	6.00^{b}	5.00^{a}	6.00^{bcdf}
39	Melkassa 4	5.00^{b}	6.25^{cd}	6.75^{bc}	7.25^{ab}	7.00^{bc}	4.75^{fg}	4.25^{ef}	4.25^{bc}	5.69^{defghi}
40	Melkassa 5	5.00^{b}	6.00^{de}	6.75^{bc}	7.00^{bcd}	7.00^{bc}	4.25^{hi}	3.50^{gh}	3.00^{fgh}	5.31^{hjki}
41	Melkassa 7	3.50^{fg}	6.00^{de}	7.25^{ab}	7.00^{bcd}	6.25^{cde}	6.00^{e}	6.00^{b}	4.00^{bcd}	5.75^{defghi}
42	MH 141	4.25^{cde}	7.00^{b}	7.00^{bc}	7.25^{ab}	5.00^{fg}	2.00^{k}	4.00^{fg}	4.00^{bcd}	5.06^{kl}
43	M-6Q	4.25^{cde}	6.00^{de}	6.50^{bcde}	7.00^{bcd}	7.00^{bc}	5.00^{fg}	5.00^{cd}	4.00^{bcd}	5.59^{gfhij}
44	MH 140	5.00^{b}	6.25^{cd}	6.50^{bcde}	7.00^{bcd}	6.25^{cde}	6.00^{e}	3.00^{hi}	3.00^{fgh}	5.37^{hijk}
45	CZL 0814	3.50^{fg}	6.00^{de}	6.00^{de}	6.50^{def}	7.00^{bc}	6.75^{cd}	5.00^{cd}	3.00^{fgh}	5.72^{defghi}
46	M-1Q	6.00^{a}	6.00^{de}	6.00^{de}	7.00^{bcd}	7.00^{bc}	5.00^{fg}	4.00^{fg}	2.50^{hg}	5.44^{ghijk}
47	CML 312	3.75^{ef}	6.00^{de}	6.00^{de}	6.00^{ef}	7.00^{bc}	7.00^{bc}	5.00^{cd}	3.00^{fgh}	5.47^{ghijk}
48	CML395	4.00^{def}	6.00^{de}	6.00^{de}	6.00^{ef}	6.00^{de}	6.00^{e}	7.00^{a}	3.00^{fgh}	5.50^{jhijk}
49	CML 536	4.00^{def}	3.75^{jk}	5.75^{ef}	6.50^{def}	6.00^{de}	6.00^{e}	5.00^{cd}	3.00^{fgh}	5.13^{kl}
50	CML 445	5.00^{b}	5.00^{gh}	6.00^{de}	6.00^{ef}	7.00^{bc}	7.00^{bc}	6.50^{ab}	3.00^{fgh}	5.69^{defghi}
51	CML 539	4.00^{def}	6.00^{de}	6.50^{bcde}	6.25^{def}	7.00^{bc}	7.00^{bc}	3.50^{gh}	3.25^{efg}	5.44^{ghijk}
52	CML 202	5.00^{b}	6.00^{de}	6.00^{de}	7.00^{bcd}	7.00^{bc}	7.00^{bc}	7.00^{a}	4.00^{bcd}	6.13^{abcd}
53	CML 547	4.00^{def}	6.00^{de}	7.00^{bc}	7.00^{bcd}	7.00^{bc}	8.00^{a}	6.00^{b}	3.00^{fgh}	6.00^{bcdef}
54	CML 444/547	5.00^{b}	6.00^{de}	6.00^{de}	5.00^{gh}	8.00^{a}	8.00^{a}	5.00^{cd}	4.00^{bcd}	5.88^{cdefg}
55	Zimline/kat	5.00^{b}	5.00^{gh}	6.00^{de}	6.00^{ef}	6.75^{bcd}	6.00^{e}	6.00^{b}	4.25^{bc}	5.63 ^{egfhij}
Mean		4.32	5.18	5.98	6.30	6.34	5.64	4.55	3.39	4.32
SEM (±)		0.06	0.10	0.09	0.09	0.09	0.11	0.10	0.06	0.06
LSD		0.74	0.73	0.86	0.89	0.79	0.61	0.69	0.66	0.46
Key: Dae= days after emergence; Means in the same column followed by different letters are significantly different ($p < 0.05$)										

No	Genotypes	Mean damage rating (0–9)								Mean
		20DAE	30 DAE	40 DAE	50 DAE	60 DAE	70 DAE	80 DAE	90 DAE	
CV		12.23	10.12	10.27	10.14	8.97	7.74	11.00	13.89	6.27
Key: Dae= days after emergence; Means in the same column followed by different letters are significantly different ($p < 0.05$)										

Table 2
Mean damage ratings of *S. frugiperda* infestation on selected maize genotypes at various days after emergence under open field conditions in 2023 at Melkassa Agricultural Research Centre, Ethiopia.

No	Genotypes	Mean damage rating scale (0–9),								Mean
		20DAE	30 DAE	40 DAE	50 DAE	60 DAE	70 DAE	80 DAE	90 DAE	
1	DLF002	3.50^{a}	6.00^{ab}	7.00^{a}	7.00^{a}	6.75^{a}	6.50^{a}	5.25^{ab}	5.00^{abc}	5.88^{a}
2	DLF005	3.75^{a}	4.25^{bcd}	3.75^{b}	4.25^{b}	4.00^{b}	4.00^{c}	4.25^{bc}	4.25^{abc}	4.06^{b}
3	DLF026	3.57^{a}	4.25^{bcd}	4.25^{b}	$4.00^{}$	3.75^{b}	3.75^{c}	3.75^{c}	3.50^{c}	3.84^{b}
4	DLF038	4.50^{a}	5.00^{bcd}	6.75^{a}	7.25^{a}	7.00^{a}	6.00^{ab}	5.50^{ab}	5.25^{ab}	5.91^{a}
5	DLF042	3.50^{a}	3.50^{d}	4.25^{b}	4.00^{b}	3.75^{b}	3.50^{c}	3.50^{c}	4.00^{abc}	3.75^{b}
6	DLF150	4.25^{a}	5.75^{abc}	6.75^{a}	7.00^{a}	7.25^{a}	6.50^{a}	6.00^{a}	5.50^{a}	6.13^{a}
7	DLF173	4.25^{a}	5.50^{abc}	7.00^{a}	7.50^{a}	7.50^{a}	6.75^{a}	6.25^{a}	5.50^{a}	6.28^{a}
8	DLF175	3.75^{a}	4.50^{bcd}	4.25^{b}	4.50^{b}	3.75^{b}	4.25^{c}	4.25^{bc}	3.75^{bc}	4.13^{b}
9	DLF192	3.75^{a}	4.50^{bcd}	4.50^{b}	4.50^{b}	4.00^{b}	4.25^{c}	4.25^{bc}	4.00^{abc}	4.22^{b}
10	DLF211	5.25^{a}	6.00^{ab}	7.00^{a}	7.00^{a}	7.00^{a}	7.25^{a}	5.25^{ab}	4.75^{abc}	6.19^{a}
11	DLF213	3.75^{a}	4.00^{cd}	4.25^{b}	4.25^{b}	4.00^{b}	4.25^{c}	4.25^{bc}	4.25^{abc}	4.13^{b}
12	DLF2423002	4.75^{a}	7.00^{a}	7.25^{a}	7.25^{a}	6.75^{a}	6.25^{a}	5.50^{ab}	4.75^{abc}	6.19^{a}
13	DLF2423007	4.25^{a}	4.25^{bcd}	4.75^{b}	4.75^{b}	4.50^{b}	4.25^{c}	4.50^{bc}	4.50^{abc}	4.47^{b}
14	DLF2423012	4.00^{a}	4.25^{bcd}	4.75^{b}	4.25^{b}	4.50^{b}	4.50^{bc}	4.50^{bc}	4.00^{abc}	4.35^{b}
15	DLF2423015	4.25^{a}	6.00^{ab}	7.00^{a}	7.00^{a}	7.25^{a}	6.50^{a}	6.00^{a}	5.25^{ab}	6.16^{a}
Mean		4.07	4.98	5.66	5.63	5.45	5.37	4.87	4.55	5.05
SEM (±)		0.11	0.15	0.19	0.19	0.21	0.18	0.13	0.11	0.14
LSD		1.99	1.89	1.45	1.36	1.61	1.66	1.39	1.62	0.76
CV		19.26	14.95	10.23	9.47	11.63	12.46	11.25	14.01	5.92
Key: Dae = days after emergence, means in the same column followed by different letters are significantly different ($p < 0.05$)										

Table 3

Mean damage ratings of *S. frugiperda* infestation on different sorghum genotypes at various days after emergence under artificial infestation in a lath house during 2022 at Melkassa Agricultural Research Centre, Ethiopia.

No	Genotypes	Mean Damage rating scale (0–9)									Mean
		20DAE	30 DAE	40 DAE	50 DAE	60 DAE	70 DAE	80 DAE	90 DAE	100 DAE	
1	ETSC19048-4-7	4.00^{bcd}	4.00^{e}	3.25^{f}	3.25^{cd}	3.50^{de}	3.00^{f}	3.00^{d}	3.00^{f}	3.00^{ij}	3.33^{ef}
2	ETSC19182-8-7	4.50^{abc}	5.00^{abc}	5.75^{bcd}	7.00^{ab}	6.50^{abc}	6.25^{cd}	6.25^{abc}	5.25^{bcd}	4.75^{cdef}	5.69^{abcd}
3	ETSC19125-11-8	4.25^{abcd}	5.25^{ab}	6.25^{abc}	7.25^{ab}	7.00^{abc}	5.75^{cd}	6.25^{abc}	5.75^{abcd}	5.50^{abc}	5.92^{abcd}
4	ETSC17258-5-2	4.25^{abcd}	5.50^{a}	6.25^{abc}	6.25^{b}	6.50^{abc}	6.25^{cd}	6.25^{abc}	5.75^{abcd}	5.50^{abc}	5.83^{abcd}
5	ETSC19126-4-8	3.75^{bcde}	5.50^{a}	5.75^{bcd}	6.25^{b}	6.75^{abc}	7.75^{a}	6.00^{abc}	6.00^{abc}	5.00^{bcdef}	5.86^{abcd}
6	ETSC19181-14-8	3.50^{cde}	4.20^{de}	3.00^{f}	3.50^{cd}	3.25^{de}	3.25^{ef}	3.25^{d}	3.25^{f}	3.25^{hij}	3.38^{ef}
7	ETSC19071-4-8	4.50^{abc}	5.00^{abc}	6.50^{ab}	6.50^{ab}	6.25^{abc}	6.75^{abcd}	6.25^{abc}	5.75^{abcd}	4.75^{cdef}	5.80^{abcd}
8	ETSC19183-6-7	4.25^{abcd}	4.75^{bcd}	6.50^{ab}	7.00^{ab}	6.25^{abc}	5.75^{cd}	5.75^{abc}	5.50^{abcd}	5.25^{abcde}	5.67^{bcd}
9	ETSC1948-7-4	5.25^{a}	4.75^{bcd}	7.00^{a}	7.25^{ab}	7.00^{abc}	6.25^{cd}	5.25^{c}	5.25^{bcd}	5.25^{abcde}	5.92^{abcd}
10	ETSC19049-5-4	4.50^{abc}	4.75^{bcd}	6.50^{ab}	7.50^{a}	7.50^{a}	6.75^{abcd}	5.50^{bc}	5.75^{abcd}	6.00^{ab}	6.08^{ab}
11	ETSC19160-8-7	3.75^{bcde}	4.75^{bcd}	6.00^{abc}	6.50^{ab}	6.25^{bc}	6.25^{cd}	6.75^{abc}	6.25^{ab}	5.75^{abc}	5.80^{abcd}
12	Argiti	3.75^{bcde}	5.00^{abc}	5.75^{bcd}	7.00^{ab}	7.00^{abc}	7.00^{abc}	6.25^{abc}	6.50^{a}	6.00^{ab}	6.03^{abc}
13	ETSC18086-27-1	4.00^{bcd}	5.00^{abc}	6.50^{ab}	6.25^{b}	6.50^{abc}	6.50^{bcd}	6.75^{abc}	6.50^{a}	6.25^{a}	5.92^{abcd}
14	ETSC17488-50-3	3.60^{cde}	4.75^{bcd}	3.00^{f}	3.25^{cd}	3.50^{de}	3.00^{f}	3.00^{d}	3.00^{f}	2.75^{j}	3.27^{f}
15	ETSC19048-15-4	4.50^{abc}	5.00^{abc}	6.50^{ab}	6.50^{ab}	6.75^{abc}	6.00^{cd}	6.00^{abc}	5.50^{abcd}	5.75^{abc}	5.83^{abcd}
16	ETSC19129-26-8	4.00^{bcd}	5.00^{abc}	6.25^{abc}	7.25^{ab}	7.00^{abc}	6.75^{abcd}	5.75^{abc}	5.25^{bcd}	5.25^{abcde}	5.83^{abcd}
17	ETSC17497-67-5	4.00^{bcd}	5.00^{abc}	5.75^{bcd}	6.75^{ab}	7.00^{abc}	6.75^{abcd}	6.25^{abc}	5.75^{abcd}	6.00^{ab}	5.92^{abcd}
18	ETSC17483-252-2	4.25^{abcd}	5.00^{abc}	7.00^{a}	7.25^{ab}	6.75^{abc}	6.50^{bcd}	5.50^{bc}	5.50^{abcd}	6.25^{a}	6.00^{abc}
19	ETSC19059-9-4	4.00^{bcd}	5.00^{abc}	5.75^{bcd}	6.50^{ab}	6.75^{abc}	6.25^{cd}	6.50^{ab}	5.25^{bcd}	4.50^{cdef}	5.61^{cd}
20	ETSC19181-12-8	4.75^{ab}	5.00^{abc}	4.75^{edc}	7.00^{ab}	7.00^{abc}	6.25^{cd}	6.00^{abc}	5.75^{abcd}	5.75^{abc}	5.81^{abcd}
21	ETSC19159-1-4	4.50^{abc}	5.00^{abc}	5.50^{bdc}	7.25^{ab}	7.50^{a}	7.00^{abc}	6.00^{abc}	5.50^{abcd}	5.00^{bcdef}	5.92^{abcd}
22	ETSC17352-10-2	4.25^{abcd}	5.00^{abc}	5.75^{bcd}	6.50^{ab}	6.75^{abc}	6.50^{bcd}	6.00^{abc}	5.00^{cd}	5.00^{bcdef}	5.64^{bcd}

Key: DAE= days after emergence; means in the same column followed by different letters are significantly different ($p < 0.05$)

No	Genotypes	Mean Damage rating scale (0–9)									Mean
		20DAE	30 DAE	40 DAE	50 DAE	60 DAE	70 DAE	80 DAE	90 DAE	100 DAE	
23	ETSC19128-21-4	4.75^{ab}	5.50^{a}	6.25^{abc}	7.50^{a}	6.75^{abc}	6.50^{bcd}	5.50^{bc}	5.25^{bcd}	5.00^{bcdef}	5.89^{abcd}
24	ETSC19048-11-4	3.50^{cde}	4.50^{cde}	3.00^{f}	3.00^{cd}	3.00^{e}	3.25^{ef}	3.00^{d}	3.00^{f}	3.00^{hi}	3.24^{f}
25	ETSC17213-1-3	2.75^{e}	4.50^{cde}	3.75^{ef}	3.50^{cd}	3.00^{e}	3.00^{f}	3.25^{d}	3.00^{f}	3.25^{hij}	3.33^{ef}
26	ETSC19161-5-12	4.00^{bcd}	4.50^{cde}	3.50^{f}	3.50^{cd}	3.00^{e}	3.50^{de}	3.25^{d}	3.00^{f}	3.25^{hij}	3.50^{ef}
27	ETSC19032-38-4	3.75^{bcde}	5.00^{abc}	5.25^{dc}	7.00^{ab}	7.50^{a}	6.50^{bcd}	6.00^{abc}	5.50^{abcd}	5.00^{bcdef}	5.72^{abcd}
28	ETSC19181-12-7	3.25^{cde}	4.75^{bcd}	3.50^{f}	3.00^{cd}	3.00^{e}	3.25^{ef}	3.50^{d}	3.25^{f}	3.50^{ghij}	3.44^{ef}
29	ETSC19048-16-8	3.25^{cde}	4.75^{bcd}	3.75^{ef}	3.25^{cd}	3.50^{de}	3.25^{ef}	3.00^{d}	2.75^{f}	2.75^{j}	3.36^{ef}
30	ETSC19160-6-4	3.50^{cde}	4.50^{cde}	3.50^{f}	3.25^{cd}	3.25^{de}	4.25^{e}	3.00^{d}	2.75^{f}	3.00^{hi}	3.44^{ef}
31	ETSC19125-12-4	3.75^{bcde}	5.00^{abc}	3.50^{f}	3.00^{cd}	3.00^{e}	2.75^{f}	2.75^{d}	3.00^{f}	3.00^{hi}	3.30^{f}
32	ETSC19142-17-4	3.25^{cde}	4.75^{bcd}	3.25^{f}	3.25^{cd}	3.25^{de}	3.25^{ef}	3.25^{d}	3.00^{f}	3.50^{ghij}	3.41^{ef}
33	ETSC19166-8-4	3.50^{cde}	4.75^{bcd}	3.50^{f}	3.00^{cd}	3.00^{e}	3.50^{ef}	3.50^{d}	3.75^{ef}	4.00^{fghi}	3.61^{ef}
34	ETSC19125-14-8	3.75^{bcde}	5.00^{abc}	5.50^{bdc}	6.25^{b}	6.50^{abc}	6.25^{cd}	6.00^{abc}	6.00^{ab}	5.00^{bcdef}	5.58^{cd}
35	ETSC19145-8-8	3.25^{cde}	5.00^{abc}	3.25^{f}	3.25^{cd}	3.25^{de}	3.00^{f}	3.00^{d}	3.00^{f}	3.00^{hi}	3.33^{ef}
36	ETSC17491-193-3	3.50^{cde}	5.00^{abc}	5.75^{bcd}	6.75^{ab}	7.25^{ab}	7.00^{ab}	5.25^{c}	4.75^{cd}	4.50^{cdef}	5.58^{cd}
37	ETSC14695-1-2	3.50^{cde}	4.75^{bcd}	3.50^{f}	3.75^{cd}	3.50^{de}	3.75^{ef}	3.25^{d}	3.75^{ef}	3.50^{ghij}	3.69^{abcd}
38	ETSC17483-231-2	4.25^{abcd}	5.00^{abc}	5.75^{bcd}	6.50^{ab}	6.50^{abc}	6.25^{cd}	5.50^{bc}	4.75^{cd}	5.00^{bcdef}	5.50^{d}
39	ETSC19125-2-4	3.50^{cde}	5.00^{abc}	5.50^{bdc}	6.50^{ab}	6.50^{abc}	6.50^{bcd}	6.00^{abc}	6.00^{ab}	6.25^{a}	5.75^{abcd}
40	ETSC19058-9-4	3.75^{bcde}	5.00^{abc}	5.75^{bcd}	6.25^{b}	7.00^{abc}	7.50^{ab}	6.25^{abc}	6.25^{ab}	5.75^{abc}	5.95^{abcd}
41	ETSC17258-3-2	3.75^{bcde}	4.75^{bcd}	2.75^{f}	2.75^{c}	3.50^{de}	3.25^{ef}	3.00^{d}	3.00^{f}	3.00^{hi}	3.30^{f}
42	ETSC19141-17-4	3.75^{bcde}	5.00^{abc}	5.25^{dc}	6.75^{ab}	7.50^{a}	6.50^{bcd}	5.75^{abc}	5.25^{bcd}	5.00^{bcdef}	5.64^{bcd}
43	ETSC180476-21-1	4.00^{bcd}	5.00^{abc}	6.00^{abc}	6.25^{b}	6.00^{c}	5.75^{d}	5.75^{abc}	5.25bcd	5.50^{abc}	5.50^{d}
44	ETSC1915363-1-2	3.25^{cde}	4.75^{bcd}	3.25^{f}	4.00	4.25^{d}	3.50^{ef}	3.75^{d}	3.75^{ef}	3.50^{ghij}	3.78^{e}
45	ETSC17490-64-3	3.25^{cde}	5.00^{abc}	6.25^{abc}	6.75^{ab}	7.25^{ab}	6.75^{abcd}	6.25^{abc}	5.50^{abcd}	4.50^{cdef}	5.72^{abcd}

Key: DAE= days after emergence; means in the same column followed by different letters are significantly different ($p < 0.05$)

No	Genotypes	Mean Damage rating scale (0–9)									Mean
		20DAE	30 DAE	40 DAE	50 DAE	60 DAE	70 DAE	80 DAE	90 DAE	100 DAE	
46	ETSC17491-154-1	3.25^{cde}	5.25^{ab}	6.25^{abc}	7.00^{ab}	7.25^{ab}	6.25^{cd}	6.25^{abc}	5.25^{bcd}	4.25^{def}	5.61^{cd}
47	ETSC19132-4-8	3.25^{cde}	5.25^{ab}	7.00^{a}	7.00^{ab}	6.75^{abc}	7.00^{ab}	6.25^{abc}	6.00^{ab}	5.75^{abc}	6.14^{a}
48	ETSC19125-10-4	3.25^{cde}	5.25^{ab}	5.25^{dc}	6.50^{ab}	6.75^{abc}	6.50^{bcd}	6.25^{abc}	5.75^{abcd}	4.75^{cdef}	5.75^{abcd}
49	ETSC19056-10-4	3.70^{bcde}	5.00^{abc}	6.00^{abc}	7.00^{ab}	6.75^{abc}	6.50^{bcd}	6.50^{ab}	6.00^{ab}	5.75^{abc}	5.92^{abcd}
50	Melkam	3.50^{cde}	4.75^{bcd}	3.25^{f}	3.25cd	3.00^{e}	3.00^{e}	3.00^{d}	3.00^{f}	3.25^{hij}	3.33^{ef}
	Mean	3.83	4.71	6.07	5.59	5.62	5.41	5.05	5.26	5.09	5.05
	SEM (±)	1.03	0.48	1.53	1.84	1.88	1.76	1.54	1.43	1.34	1.18
	LSD	1.09	0.63	1.15	1.11	1.15	1.21	1.05	1.13	1.17	0.45
	CV	20.19	9.22	16.27	14.19	14.70	16.04	14.89	16.89	18.19	6.49

Key: DAE= days after emergence; means in the same column followed by different letters are significantly different ($p < 0.05$)

Table 4
Mean damage ratings of *S. frugiperda* infestation on selected sorghum genotypes at various days after emergence under open field conditions in 2023 at Melkassa Agricultural Research Centre, Ethiopia.

No	Genotypes	Mean damage rating scale (0–9)									Mean
		20DAE	30 DAE	40 DAE	50 DAE	60 DAE	70 DAE	80 DAE	90 DAE	100 DAE	
1	ETSC19048-4-7	4.00b	5.00^{abc}	5.00^{cd}	4.66^{def}	4.33^{def}	4.33^{cd}	4.00^{g}	3.67^{ef}	3.67^{def}	4.29^{ef}
2	ETSC19181-14-8	4.66^{ab}	5.66^{ab}	6.67^{ab}	7.00^{abc}	7.33^{ab}	7.67^{a}	7.33^{ab}	6.67^{a}	6.00^{a}	6.55^{a}
3	ETSC17488-50-3	4.33^{ab}	4.33^{c}	4.67^{cd}	4.33^{ef}	4.33^{def}	4.67^{cd}	4.67^{efg}	4.00^{def}	3.67^{def}	4.33^{ef}
4	ETSC19048-11-4	4.33^{ab}	5.67^{ab}	6.67^{ab}	8.00^{a}	8.00^{a}	7.67^{a}	7.33^{ab}	5.66^{abc}	5.00^{abc}	6.48^{a}
5	ETSC17213-1-3	4.66^{ab}	5.67^{ab}	7.00^{a}	7.00^{abc}	7.33^{ab}	7.67^{a}	7.67^{a}	6.66^{a}	5.66^{ab}	6.59^{a}
6	ETSC19161-5-12	4.66^{ab}	4.67^{c}	5.00^{cd}	5.00^{def}	5.33^{cd}	5.66^{ab}	5.33^{defg}	4.66^{cde}	4.00^{cdef}	4.92^{de}
7	ETSC19181-12-7	4.00^{b}	4.67^{c}	4.33^{d}	4.67^{def}	3.67^{f}	4.33^{cd}	4.33^{fg}	4.00^{def}	3.33^{ef}	4.15^{ef}
8	ETSC19048-16-8	4.33^{ab}	5.00^{abc}	6.67^{ab}	7.00^{abc}	7.33^{ab}	7.67^{a}	7.33^{ab}	6.00^{ab}	5.00^{abc}	6.59^{a}
9	ETSC19160-6-4	4.67^{ab}	6.00^{a}	7.00^{a}	6.67^{abc}	7.33^{ab}	6.67^{ab}	6.33^{abcd}	6.67^{a}	6.00^{a}	6.37^{ab}
10	ETSC19125-12-4	4.33^{ab}	4.67^{c}	4.33^{d}	4.00^{f}	4.00^{ef}	4.00^{d}	4.00^{g}	4.00^{def}	3.66^{def}	4.11^{ef}
11	ETSC19142-17-4	4.00^{b}	4.33^{c}	4.67^{cd}	5.00^{def}	4.67^{def}	4.33^{cd}	4.33^{fg}	3.67^{ef}	3.00^{f}	4.23^{ef}
12	ETSC19166-8-4	4.00^{b}	5.00^{abc}	5.33^{bcd}	7.33^{ab}	7.33^{ab}	7.33^{a}	7.00^{abc}	6.00^{ab}	5.00^{ab}	6.04^{ab}
13	ETSC19145-8-8	3.67^{b}	4.33^{c}	4.33^{d}	4.66^{def}	4.00^{ef}	4.00^{d}	4.00^{g}	3.33^{f}	3.33^{ef}	3.96^{f}
14	ETSC14695-1-2	4.00^{b}	5.67^{ab}	6.00^{abc}	6.00^{bcd}	6.33^{bc}	6.67^{ab}	6.00^{bcde}	5.00^{bcd}	4.33^{cde}	5.55^{bcd}
15	ETSC17258-3-2	4.00^{b}	5.00^{abc}	6.00^{abc}	5.67^{cde}	5.67^{cd}	6.33^{ab}	5.67^{cdef}	4.67^{cde}	4.33^{cde}	5.25^{cd}
16	ETSC1915363-1-2	5.33^{a}	5.33^{abc}	6.00^{abc}	7.33^{ab}	7.67^{ab}	7.67^{a}	7.00^{abc}	6.33^{a}	4.66^{bcd}	6.37^{ab}
17	Melkam	4.33^{ab}	5.33^{abc}	7.00^{a}	7.00^{abc}	7.33^{ab}	7.67^{a}	6.67^{abcd}	6.33^{a}	4.66^{bcd}	6.25^{ab}
	Mean	4.31	5.08	5.68	5.96	5.99	6.14	5.82	5.13	4.43	5.41
	SEM (±)	0.11	0.11	0.18	0.20	0.24	0.24	0.22	0.19	0.16	0.16
	LSD	1.21	1.09	1.49	1.47	1.44	1.62	1.53	1.23	1.01	0.91
	CV	16.92	12.89	15.73	14.81	14.41	15.85	15.76	14.41	13.70	13.11

Key: Dae= days after emergence, Means in the same column followed by different letters are significantly different ($p < 0.05$)

4. Discussions

4.1. Screening maize genotypes against *S. frugiperda* both in the lath house and field conditions

The experiment was conducted both in the lath house and in field conditions. The promising materials selected from the lath house experiment were further evaluated in the field conditions. The results indicated that, at beyond 20 days after emergences up to the final maturity stages, significantly lower damage scores were recorded for DLF002, DLF005, DLF026, DLF038, DLF042, DLF150, DLF173, DLF175, DLF192, DLF211, DLF213, DLF2423002, DLF2423007 genotypes which was ranging from 3.00 to 5.00 were recorded, however, significantly (P<0,05) higher damage scores were observed in the others genotypes which was ranging from 3.00 to 8.00. Similarly, the field evaluation showed that significantly (P<0.05) lower damage scores were depicted in DLF005, DLF026, DLF042, DLF175, DLF192, DLF213, DLF2423007, and DLF2423012 genotypes, which ranged from 3.75 to 4.75; nevertheless, significantly (P<0.05) maximum

damage scores were observed in the other genotypes, which ranged from 4.25 to 7.25. The current results are in accordance with various research outputs from the global literature. According to Sugeetha et al. (2024), among the 210 maize inbred lines evaluated against *S. frugiperda*, 155 inbreds were categorized under least susceptible (1- 4); among them, 10 lines were found to be the least susceptible with the lowest damage score (1- 1.5). Forty-nine inbreds were grouped under the moderately susceptible category (4-7), whereas six were found to be highly susceptible (7-9).

Similar results were also observed by Xinzhi et al. (2014), who screened various experimental lines by visual observation of damage rating score 0-9 scale, and reported that 'Mp708' and 'FAW7061' were the most resistant, whereas 'Ab24E' and 'EPM6' were the most susceptible to fall armyworm feeding. Praveen et al. (2013) reported that the lowest scoring of leaf damage was recorded in maize resistant variety NAC-6002 (0.66 and 2.33) against *Chilo partellus,* and the highest scoring was in susceptible variety Basi-local (6.00 and 7.00) at 30 DAS and 60 DAS, respectively. Similarly, Darshan et al.(2024) reported that among fifteen different maize cultivars screened against fall armyworm, variety Kaveri minchu recorded the highest mean leaf damage score (4.62), whereas the hybrid PMH 224 recorded the least mean leaf damage score (0.73).

In addition, Ni et al. (2014) found significant differences among 22 maize inbred lines after rating the levels of leaf injury at 7 d (0.0003) and 14 d (0.005) after the infestation. The results of Oliviera et al. (2018) showed significant differences among genotypes for all characters evaluated related to FAW foliar feeding, thereby revealing the existence of significant genetic variability. Chen et al. (2009) attributed the basis of the conventional resistance in MP 708 to the elevated defensive proteins following insect herbivory. They indicated the conversion of photosynthates to defensive proteins and constitutive accumulation of jasmonic acid.

4.2. Screening sorghum genotypes against *S. frugiperda* both in the lath house and field conditions

The screening of sorghum genotypes was conducted both in a lath house and under field conditions, providing a comprehensive assessment of their performance against pest pressures. The results indicated that several genotypes, including ETSC19048-4-7, ETSC19181-14-8, ETSC17488-50-3, ETSC19048-11-4, ETSC17213-1-3, ETSC19161-5-12, ETSC19181-12-7, ETSC19048-16-8, ETSC19160-6-4, ETSC19125-12-4, ETSC19142-17-4, ETSC19166-8-4, ETSC19145-8-8, ETSC14695-1-2, ETSC17258-3-2, ETSC1915363-1-2, and Melkam exhibited significantly lower damage scores ($P<0.05$) throughout their growth stages, with scores ranging from 2.75 to 4.75. This suggests that these genotypes possess genetic traits that confer resistance to pests, which is critical for sustainable agricultural practices. Lower damage scores not only indicate better pest resistance but also correlate with improved growth and yield potential, ultimately supporting food security. In contrast, other genotypes recorded significantly higher damage scores, with means ranging from 3.25 to 7.25. This variance underscores the importance of genetic diversity within sorghum breeding programs, as it highlights the potential for selecting and developing more resilient cultivars. The findings from field experiments further corroborated the laboratory results, showing that genotypes such as ETSC19048-4-7, ETSC17488-50-3, ETSC19161-5-12, ETSC19181-12-7, ETSC19125-12-4, ETSC19142-17-4, and ETSC19145-8-8 consistently achieved minimum damage scores between 4.00 and 5.00. This consistency across different growing conditions reinforces the reliability of these genotypes under natural pest pressures, an essential factor for farmers who depend on stable crop performance.

The current results align with historical data, such as the work by Montes et al. (1996), which identified specific inbred lines that displayed lower damage ratings against *S. frugiperda*. Their findings highlight the potential for breeding programs to focus on lines with proven resistance traits, paving the way for more robust agricultural systems. Furthermore, Njogu et al. (2025) provided insights into the mechanisms behind resistance, noting that certain genotypes, including GBK 000446, IS 21055, GBK 000121, GBK 000392, and IESV 92022/1-SH, exhibited reduced performance of FAW in terms of pupal weight, larval weight, and the number of adults emerging. This points to the importance of understanding the biological interactions between pests and host plants, as such knowledge can inform breeding strategies aimed at enhancing pest resistance. Harris et al. (2015) also contributed valuable findings by examining the responses of various sweet sorghum genotypes to *S. frugiperda* feeding. They noted that both susceptible and resistant varieties experienced reduced damage as they matured, with resistant varieties transitioning from juvenile to adult phases more rapidly. This early maturation could be a crucial factor in pest management, as it allows plants to escape peak pest populations, thereby reducing overall damage. Moreover, studies have shown that hemicellulose levels tend to be higher in resistant genotypes and older plants, suggesting a potential link between these biochemical traits and resistance to *S. frugiperda*. This relationship was echoed by Souza et al. (2023), who highlighted that early-maturing sorghum varieties in Honduras suffered less damage, further emphasizing the importance of breeding strategies that incorporate both growth traits and pest resistance.

Resistance mechanisms may manifest in various ways, including antibiosis, which reduces pest survival rates, and decreased attractiveness to pests, leading to lower oviposition rates. Understanding these mechanisms is vital for developing effective pest

management strategies and breeding programs aimed at improving crop resilience. In conclusion, the results of this study not only identify promising sorghum genotypes for pest resistance but also underscore the broader implications for sustainable agriculture. By focusing on the genetic traits that confer resistance, researchers and breeders can enhance crop resilience, reduce dependency on chemical pest control, and ultimately contribute to sustainable food production systems essential for meeting global food security challenges.

4.3. Conclusions and Recommendations

Relative host plant resistance is one of the most sustainable and environmentally friendly pest management strategies, as it reduces reliance on synthetic insecticides, which often pose risks of pest resistance development, non-target effects, and environmental contamination. A resistant genotype, when integrated with suitable cultural practices such as the use of healthy planting materials, balanced soil fertility management, and timely weed suppression, can significantly minimize the need for chemical sprays while ensuring stable crop yields. Results from the current studies demonstrate that the tested sorghum and maize genotypes influenced the different developmental stages of the fall armyworm (FAW), suggesting that certain genotypes possess inherent resistance to the pest.

In the current evaluation, eight maize genotypes, DLF005, DLF026, DLF042, DLF175, DLF192, DLF213, DLF2423007, and DLF2423012, consistently exhibited reduced levels of FAW-induced leaf damage under both lath house and field conditions. Likewise, seven sorghum genotypes, ETSC19048-4-7, ETSC17488-50-3, ETSC19161-5-12, ETSC19181-12-7, ETSC19125-12-4, ETSC19142-17-4, and ETSC19145-8-8, showed significantly lower damage compared to other tested lines across both experimental setups. The consistency of these results across environments strengthens the evidence that these genotypes harbour heritable traits conferring resistance to *S. frugiperda*. From a scientific perspective, resistance in maize and sorghum may arise from morphological, physiological, and biochemical mechanisms**.** Morphological defences include leaf toughness, trichome density, or waxy coatings that physically deter larval feeding. Physiological and biochemical mechanisms often involve secondary metabolites, such as phenolic compounds, flavonoids, and defensive proteins, which can either reduce the palatability of plant tissues or impair larval growth and survival. Additionally, some resistant genotypes may trigger induced defence responses, releasing volatile organic compounds that attract natural enemies of *S. frugiperda*, thereby providing indirect protection.

The identified maize and sorghum genotypes are therefore promising candidates for breeding programs aimed at developing resistant cultivars**,** which can serve as the foundation of an integrated pest management (IPM) strategy. Incorporating these genotypes into breeding pipelines will not only contribute to sustainable *S. frugiperda* management but also enhance food security by reducing production losses. Future research should focus on detailed morpho-physiological and molecular characterization of these genotypes to pinpoint the exact resistance mechanisms and potentially identify genetic markers for resistance. Such advances would accelerate the development of elite varieties that combine *S. frugiperda* resistance with high yield potential and adaptability to local agroecological conditions.

Declarations

Consent for publication

This manuscript does not contain any person's data in any form (including individual details, images, or videos), and therefore, consent for publication is not applicable.

Competing interests

The authors declare that they have no competing interests

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Author Contribution

1. Ahmed Ibrahim: Conceptualisation, Data curation, Formal analysis, Methodology, Validation, Investigation, Visualisation, Software, Writing – original draft, Writing – review & editing2. Emana Getu: Conceptualisation, Investigation, Methodology, Validation, Supervision, Writing – review & editing, Proposal writing, Data analysis, and editing. 3. Dawit Tesfaye: Data curation, Formal analysis, Investigation, Methodology, Software, Validation, Visualisation, Writing – review & editing 4. Girma Demise: Methodology, Supervision, Visualisation, Validation, Writing – review & editing.

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