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PRELIMINARY ASSESSMENT OF MAIZE GENOTYPES AGAINST STORAGE INFESTATION BY *Sitotroga cerealella* (Olivier)

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ABSTRACT

Sitotroga cerealella is a major storage pest that significantly impacts maize grain quality and yield. This study evaluated the resistance of six maize genotypes (ART98SWB, DMR-ESR-Y, LNTP-Y, ART/98/SW9, BR9928-DMRY and T2PB-W) for resistance to *S. cerealella* infestation by assessing key parameters such as adult emergence, grain damage and weight loss. The developmental period of *S. cerealella* varied among genotypes, with the egg stage lasting 3–4 days, the larval stage 18–20 days, the pupal stage 8–9 days and the adult stage 5–7 days. Significant variation was observed in adult emergence ($F = 3.14$, $p < 0.05$), with ART98SWB exhibiting the highest emergence (25.67), while BR9928-DMRY recorded the lowest (4.23). The number of damaged grains ranged from 0.01% in LNTP-Y to 20.0% in ART98SWB, and weight loss varied from 0.00% in LNTP-Y to 20.20% in ART98SWB. A strong positive correlation was observed between grain damage and weight loss. These findings highlight genotypic differences in maize resistance to *S. cerealella*, emphasising the need to develop more resistant cultivars in breeding programmes to mitigate post-harvest losses and enhance food security.

Keywords: Maize genotypes; *Sitotroga cerealella*; resistance screening; post-harvest losses; adult emergence
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INTRODUCTION

Maize, a globally essential crop, faces significant challenges from insect pests and fungal diseases during storage, leading to substantial yield losses (Sebayang *et al*., 2023; Cervantes-Macedo *et al*., 2024). Major storage pests of maize include *Sitotroga cerealella*, *Sitophilus zeamais*, *Prostephanus truncatus* causing up to 40% damage in high moisture conditions (Opiyo, 2021; Sebayang *et al*., 2023). These pests, along with fungal diseases, pose a serious threat to food security, particularly in sub-Saharan Africa (Asibe *et al*., 2023).

The global distribution of the maize moth (*Sitotroga cerealella*) throughout Africa, Asia and the Americas, as well as in Europe, certainly can affirm its significance and indicates emphatically that there is an urgent need for effective

control strategies for this pest (Khan *et al*., 2023). Damage to stored maize by the larvae of *S. cerealella* represents a significant threat: grain quality is compromised, germination rate is significantly reduced, and vulnerability to secondary infestations is increased (Demissie *et al*., 2015). As they bore into corn kernels and nibble at the contents inside, the larvae of *S. cerealella* then fill up the resulting holes (cavities) with their excrement, further debasing its value (Berhe *et al*., 2022). Post-harvest losses due to *S. cerealella* range from 20% - 50%, which is particularly severe in Africa; hence, the need for resistant maize genotypes (Bushra and Aslam, 2014; Suleiman, 2015; López-Castillo *et al*, 2018; Swamaizei *et al*., 2019; Omwoyo *et al*., 2022). There are global efforts to identify resistant genotypes, including landraces and improved breeding lines, to support maize improvement programmes (Dossa *et al*., 2023). This initiative aimed to develop genetically resistant cultivars that can mitigate losses and enhance food security.

Management strategies involve exploring maize proteins associated with resistance (Cervantes-Macedo *et al*., 2024) and investigating plant-based insecticides as alternatives to synthetic chemicals (Opiyo, 2021). Conventional management strategies rely heavily on chemical insecticides, which present challenges such as pest resistance, environmental hazards and food safety concerns (Aktar *et al*., 2018).

Several studies have explored the genetic basis of maize resistance to *S. cerealella*, with screening efforts conducted across different regions. For instance, American researchers have evaluated both commercial hybrids and breeding lines to identify resistance sources (Santiago *et al*., 2015). In Asia, extensive screening programmes in India, China and Thailand have assessed maize cultivars and landraces for resistance traits (Hong *et al*., 2020). Similarly, in Europe, studies in high-production regions such as Italy and Spain have focused on integrating host plant resistance into pest management programmes (Stenberg, 2017).

Despite progress in maize breeding, resistant genotypes remain limited, necessitating further comprehensive screening to identify new sources of resistance. Enhancing genetic resistance to *S. cerealella* through breeding programmes can provide a long-term solution for sustainable maize production, reducing reliance on chemical control measures while ensuring grain quality and yield stability. This study aimed to evaluate selected maize genotypes for their resistance to *S. cerealella*, with the objective of identifying resistant genotypes.

MATERIALS AND METHODS

Collection of materials

Pure cultures of *S. cerealella* eggs were used for this study. The maize genotypes used (ART98SWB, DMR-ESR-Y, LNTP-Y, ART/98/SW9, BR9928-DMRY and T2PB-W) were obtained from the International Institute of Tropical Agriculture, Ibadan, Nigeria.

Culturing of *S. cerealella* and Experimental Design

Mass culturing was carried out by confining seeds of the maize containing eggs of *S. cerealella* in 18 medium-size mayonnaise jar [high density polyethylene (HDPE)]. One hundred (100) seeds of maize grains from each of the six maize genotypes were introduced into each jar in three replicates using the completely randomised design

as described by Grimm and Lawrence (1975) and Draz *et al*. (2018). The jars were covered with muslin cloth and tied with rubber band to allow fresh air. The jars were placed in the laboratory at a room temperature under normal humidity and monitored on daily basis.

Parameters used in screening maize grains for resistance to S. cerealella

A total of six maize genotypes were screened in the laboratory for resistance to *S. cerealella* where adult emergence, number of damaged and undamaged grains and weight loss were considered.

The screening of maize genotypes for resistance to *Sitotroga cerealella* was conducted by evaluating key parameters associated with infestation and damage, according to the method described by Viana *et al*. (2022). Adult emergence was recorded daily by counting the number of insects emerging from each genotype. The emerged adults were preserved for further analysis. Grain damage was assessed by examining the extent of infestation and physical deterioration of the grains caused by moth activity. Weight loss was measured to determine the reduction in grain mass due to feeding by *S. cerealella* larvae. The final evaluation of resistance levels was based on a comprehensive analysis of adult emergence, grain damage and weight loss data.

Data Collection and Statistical Analysis

Data collection was based on two key aspects: maize grain weight and *S. cerealella* development from the egg stage to adult emergence. Using a digital balance, the weight of maize grains was recorded at the initial and final set-up to assess changes due to the pest infestation. The developmental progress of *S. cerealella* was observed, with daily records of adult emergence.

Data analysis was conducted using the Statistical Analysis System (SAS 2024). The mean performance of maize grain weight from the initial set-up to adult emergence was analysed. A one-way analysis of variance (ANOVA) was performed to determine significant differences among maize genotypes in terms of resistance to *S. cerealella*. Differences between means were compared using the appropriate post-hoc test at $p< 0.05$ significance level and charts were used to show variations.

RESULTS

Development of *Sitotroga cerealella*

The developmental period of *S. cerealella* from egg to adult emergence varied across the maize genotypes (Figure 1). Oviposition stage lasted 3 to 4 days, larval stage ranged between 18 and 20 days, pupal stage 8 to 9 days and the adult emergence varied between 5 and 7 days (Figure 1).

Significant variation was observed across maize genotypes in the adult emergence of *S. cerealella* as indicated by the one-way Analysis of Variance result (ANOVA) at $F = 3.14$ and $p<0.05$ (Table 1). ART98SWB recorded the highest adult emergence (25.67), while BR9928-DMRY recorded the lowest (4.23) (Figure 2, Table 2). Low adult emergence was also observed in DMR-ESR-Y (9.33) and ART/98/SW9 (8.10), while moderately high values observed in LNTP-Y and T2PB-W, with 16.67 and 20.31, respectively (Figure 2, Table 2).

Table 1: One-way ANOVA showing the differences in adult emergence across all tested maize genotypes

Source of Variation	SS	df	MS	F	P-value
Between Groups	1100	5	220.00	3.14	*0.045
Within Groups	840.67	12	70.06		
Total	1940.67	17			

df- Degree of freedom, P-value ≤ 0.05

Table 2: Mean adult emergence of *Sitotroga cerealella* in some maize genotypes

GENOTYPE	ADULT EMERGENCE
ART98SWB	25.67
DMR-ESR-Y	9.33
LNTP-Y	16.67
ART/98/SW9	8.10
BR9928-DMRY	4.23
T2PB-W	20.31

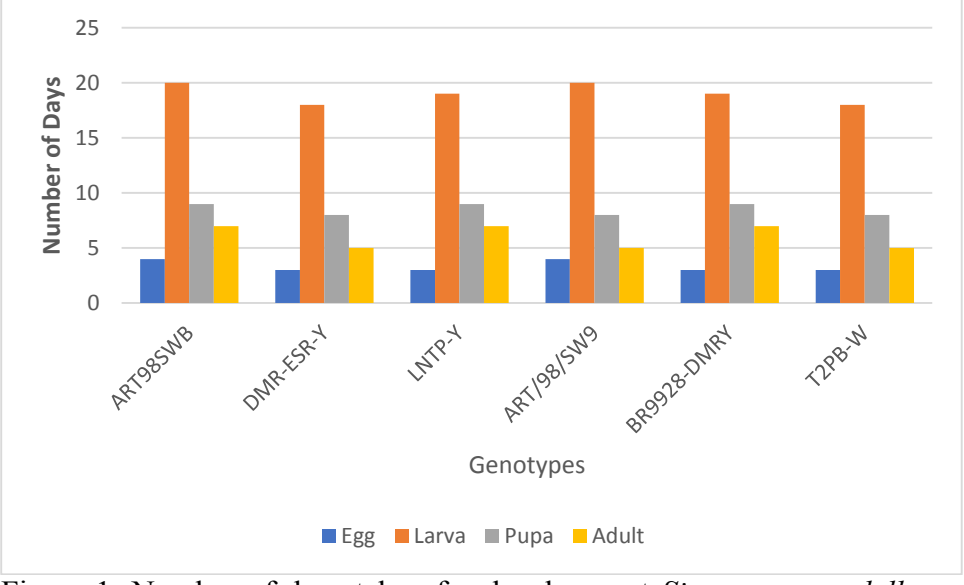


Figure 1: Number of days taken for development *Sitotroga cerealella* across maize genotypes

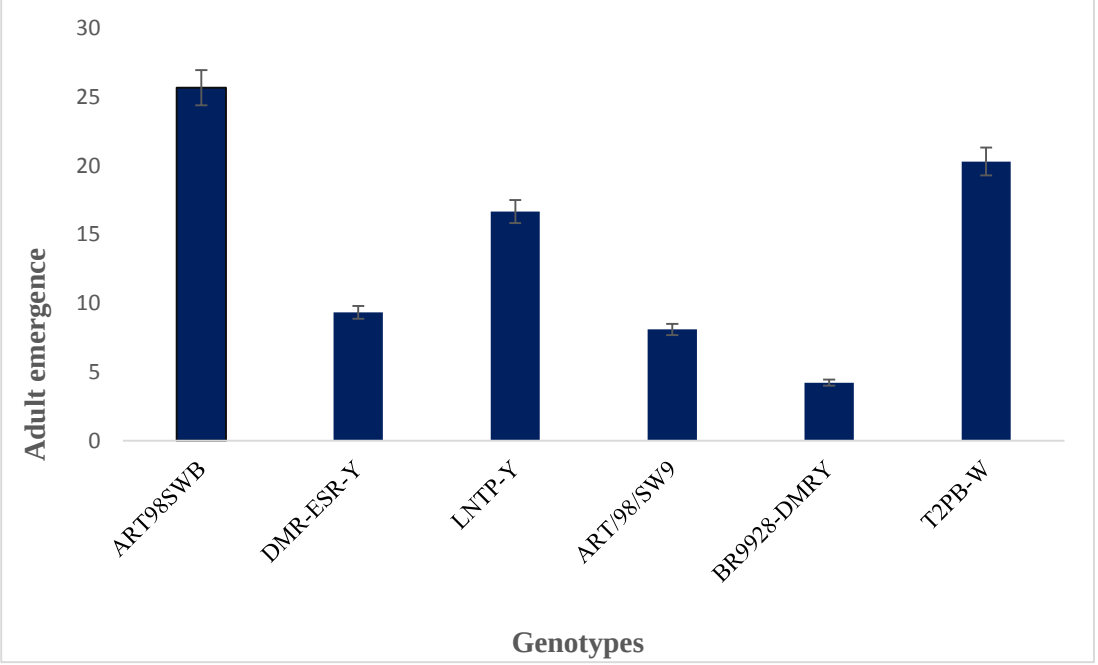


Figure 2: Number of adults of *Sitotroga cerealella* that emerged during the screening

Physical deterioration of maize grains caused by *Sitotroga cerealella*

The number of damaged grains varied among the maize genotypes, with scores ranging from 0.01% to 20.00% (Table 3). Genotype ART98SWB exhibited the highest percentage weight loss (20.20%), followed by T2PB-W (14.86%) and BR9928-DMRY (9.92%). In contrast, ART/98/SW9 (4.51%) and DMR-ESR-Y (3.26%) recorded relatively lower weight losses. Notably, LNTP-Y showed complete resistance, with 0% weight loss. These trends were consistent with the observed grain damage scores. A positive correlation was observed between the percentage of damaged grains and weight loss, as shown in Figure 3.

Table 3: Percentage weight loss of maize genotypes resulting from *Sitotroga cerealella* infestation

Genotype	Mean score of damaged grains (%)	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Percentage Weight Loss (%)
ART98SWB	20.00	261.52	208.68	52.84	20.20
DMR-ESR-Y	3.00	261.60	253.07	8.53	3.26
LNTP-Y	0.01	264.68	264.68	0.00	0.00
ART/98/SW9	4.33	264.64	252.70	11.94	4.51
BR9928-DMRY	8.67	264.61	238.37	26.24	9.92
T2PB-W	14.00	264.64	225.31	39.33	14.86

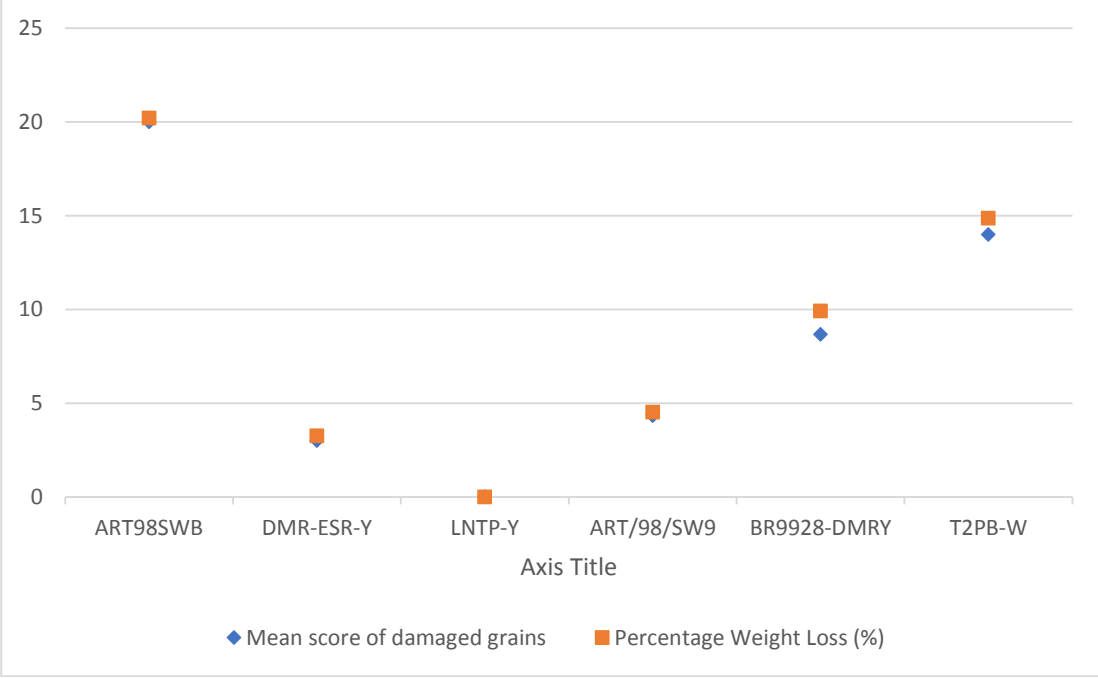


Figure 3: Correlation between damaged grains and percentage weight loss as a result of *Sitotroga cerealella* infestation

DISCUSSION

This study showed that *Sitotroga cerealella* exhibited prolonged development and reduced adult emergence in the maize genotypes, revealing its resistance to the development of the pest. This finding agrees with Boamah *et al*. (2023) who also reported delayed emergence from the third to the sixth week in certain maize genotypes. Similarly, Saikia *et al*. (2010) observed that *S. cerealella* larvae had a longer developmental period in maize (20.7 days) compared to rice (16.2 days), influencing pest population dynamics in stored grains.

The results of this study highlighted the significant influence of maize genotypes on the development and damage potential of *S. cerealella*. Variations in adult emergence, grain damage and weight loss among different maize genotypes suggests a strong genetic basis for resistance or susceptibility to this storage pest. Highly susceptible genotypes, such as ART98SWB, recorded a high weight loss of grain (20.20%) and a high adult emergence of 25.67 which resulted in a high grain damage, whereas moderately resistant genotypes like BR9928-DMRY showed lower adult emergence of 4.23. The findings in this study are in line with Boamah *et al*. (2023) who noted that resistant genotypes tend to support lower adult emergence rates, emphasising the role of genotype in reducing pest proliferation. Ahmed and Raza (2010) reported susceptible maize varieties with grain damage as high as 93.46% while Tsegab and Getu (2021) noted that maize genotypes with higher grain damage experienced greater losses due to insect feeding activity.

Genotype LNTP-Y showed moderate *S. cerealella* infestation with adult emergence of 16.65 and zero weight loss, indicating that the genotype was resistant to *S. cerealella* infestation. The findings are in line with Foaud *et al*. (2013), who

reported that lower insect emergence resulted in reduced weight loss in certain maize genotypes.

A strong positive correlation was observed between adult moth emergence and grain weight loss, indicating adult emergence is a reliable proxy for susceptibility. This finding is in line with Tadesse *et al*. (2020), who noted that increased insect emergence led to greater post-harvest losses in stored grains. Similar findings have been reported by Tembo *et al*. (2017). The results from this study underscore the importance of selecting resistant maize genotypes for storage to minimise losses. Integrating effective pest detection methods, such as those highlighted by Saikia *et al*. (2010), could aid in early detection and management of *S. cerealella* infestation, thereby reducing post-harvest losses and ensuring better grain quality.

CONCLUSION

This study demonstrated significant genotypic variations in maize resistance to *S. cerealella* infestation. Genotypes ART98SWB and T2PB-W exhibited high susceptibility, with high adult emergence, grain damage and weight loss, while BR9928-DMRY and ART/98/SW9 showed moderate resistance. The genotype LNTP-Y recorded 16.65 adult emergence with no weight loss, suggesting potential resistance mechanisms. The strong correlation between grain damage and weight loss underscores the importance of selecting resistant genotypes for breeding programmes. Integrating these resistant genotypes into maize breeding programmes could significantly reduce storage losses, ensuring better grain quality and food security. Future studies should focus on elucidating the genetic and biochemical mechanisms underlying resistance, and validating these findings under real-world storage conditions to enhance the practical application of resistant genotypes in integrated pest management strategies.

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