PRELIMINARY EVALUATION OF MAIZE GENOTYPES FOR RESISTANCE TO *Sitotroga cerealella* (ANGOUMOIS GRAIN MOTH) INFESTATION IN STORAGE

Running Title : Maize Genotypes Resistance to Grain Moth Infestation

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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) 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 found between grain damage and weight loss. These findings highlight genotypic differences in maize resistance to *S. cerealella*, emphasizing the need for resistant cultivars in breeding programs to mitigate post-harvest losses and enhance food security.

Keywords: *Sitotroga cerealella*, resistance screening, post-harvest losses, adult emergence

1.0 INTRODUCTION

Maize, a globally essential crop, faces significant challenges from insect pests and fungal diseases during storage, leading to substantial yield losses (Cervantes-Macedo et al., 2024; Sebayang et al., 2023). Major pests include *Sitotroga cerealella*, *Sitophilus zeamais*, *Prostephanus truncatus* causing up to 40% damage in high moisture conditions (Sebayang et al., 2023; Opiyo, 2021, Mishu, 2015). 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 (*S. cerealella*), spanning Africa, Asia, the Americas, and Europe, emphasizes its economic importance and the need for effective control strategies (Khan et al., 2023). The larvae of *S. cerealella* pose a severe threat to stored maize, compromising grain quality, reducing germination rates, and increasing susceptibility to secondary pest infestations (Demissie et al., 2015). 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).

Post-harvest lost as a result due to *S. cerealella* ranges from 20% - 50%, which is particularly severe in Africa, hence, the need for resistant maize Genotypes (Tefera et al., 2011; Bushra & Aslam, 2014; Suleiman, 2015 Swai et al., 2019; Omwoyo et al., 2022). Efforts have concentrated on identifying resistant maize genotypes, including landraces and improved breeding lines, to support maize improvement programs (Dossa et al., 2023). These initiatives aim to develop genetically resistant cultivars that can mitigate losses and enhance food security.

Several studies have explored the genetic basis of maize resistance to *S. cerealella*, with screening efforts conducted across different regions. For instance, America researchers have evaluated both commercial hybrids and breeding lines to identify resistance sources (Santiago et al., 2015). In Asia, extensive screening programs 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 programs (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 programs 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 and characterizing resistant Genotypes. The findings from this research will contribute to the development of sustainable maize production and storage strategies, minimizing post-harvest losses and enhancing global food security.

2.0 MATERIALS AND METHODS

2.1 Collection of materials

Pure culture of *S. cerealella* eggs were used for this study. The maize seeds Genotypes used which include 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.

2.2 Experimental Design

Mass culturing was carried out by confining seeds of the maize containing eggs of *S. cerealella* in 18 jars containing 3 different maize Genotypes with each jar containing 100 seeds of maize grains with three replicates completely randomized as described by Grimm & Lawrenc (1975) and Draz et al. (2018). The jars were covered with muslin cloth and tied with rubber band to allow fresh air into the jar. The jars were placed in the laboratory in a room temperature under normal humidity and monitored at daily bases.

2.3 Screening Parameters for Maize Resistance to *Sitotroga cerealella*

A total of six maize Genotypes were screened in the laboratory for their resistant 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 a method described by Viana et al., (2022). Adult emergence was recorded daily by counting the number of insects emerging from each hybrid. The emerged adults were preserved according to replication for further analysis. Grain damage was assessed by examining the extent of infestation and physical deterioration of the grains caused by moth activity. Additionally, 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.

2.4 Data Collection and Statistical Analysis

Data collection focused on two key aspects: maize grain weight and *S. cerealella* development from the egg stage to adult emergence. The weight of maize grains was recorded at the initial setup and monitored throughout the study to assess changes due to infestation. Additionally, the developmental progress of *S. cerealella* was observed, with daily records of adult emergence.

Statistical analysis was conducted using the Statistical Analysis System (SAS). The mean performances of maize grain weight from the initial setup to adult emergence were analyzed. 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.

3.0 RESULTS

3.1. Development of *Sitotroga cerealella*

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

Significant variation was observed across maize genotypes in the adult emergences 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 exhibited the lowest (4.23) (Figure 2, Table 2). Relatively low adult emergence was also seen in DMR-ESR-Y (9.33) and ART/98/SW9 (8.10) while moderately high were noticed in LNTP-Y and T2PB-W having 16.67 and 20.31 respectively (Figure 2. Table 2).

3.2. Physical deterioration of the maize grains caused by moth *Sitotroga cerealella* activity

The number of damaged grains varied among the tested maize Genotypes, ranging from mean score of 0.01 to 20.0 (Table 3). Genotype ART98SWB exhibited the highest percentage number of damaged grains (20%), followed by T2PB-W (14.0%). The lowest damage maize grain was observed in LNTP-Y with 0.01 (Table 3). This also had an effect in the maize grain weight loss due to *S. cerealella* infestation (Table 4). The highest percentage weight loss was recorded in ART98SWB (20.20%) while 0% weight loss was observed in genotype LNTP-Y (Table 4). Similarly, genotypes DMR-ESR-Y and ART/98/SW9 exhibited lower percentage weight loss of 3.26% and 4.51% respectively (Table 4). There was also a positive correlation between the mean percentage of damaged grains and percentage weight loss in maize Genotypes (Figure 3). The higher the number of damaged grains the higher the weight loss (Figure 3).

4.0 Discussion

In the current study *Sitotroga cerealella* exhibited prolonged development and reduced adult emergence, potentially serving as a resistance mechanism in maize. This was in agreement with Boamah et al. (2023) who also reported delayed emergence from the third to sixth week in certain maize genotypes. Similarly, Saikia et al. (2010) found 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 highlight 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 suggest a strong genetic basis for resistance or susceptibility to this storage pest. Highly susceptible genotypes, such as ART98SWB which recorded a weight loss of grain (20.20%), recorded high adult emergence (25.67 adults), indicating high grain damage, whereas moderate resistant genotypes, like BR9928-DMRY, showed substantially lower emergence (4.23 adults). Boamah et al. (2023) also noted that resistant genotypes tend to support lower adult emergence rates, reinforcing the role of genotype in limiting pest proliferation. Similar findings were reported by Ahmed and Raza (2010), where susceptible maize varieties recorded grain damage as high as 93.46% and Tsegab & Getu. (2021), who found that maize genotypes with higher grain damage experienced greater losses due to insect feeding activity.

Genotype LNTP-Y showed relatively high *S. cerealella* infestation with adult emergence 16.65 but 0.00% percentage weight loss. This outcome showed the presence of moth adult had no significant effect on the genotype maize grains, indicating putative resistance. The findings align with Foaud et al. (2013), who demonstrated that lower insect emergence resulted in reduced weight loss in certain maize genotypes.

A strong positive correlation also observed between adult moth emergence and grain weight loss, indicating adult emergence as a reliable proxy for susceptibility. This finding is in agreement with research by Tadesse et al. (2020), who demonstrated that increased insect emergence leads to greater post-harvest losses in stored grains. Similar finding was observed in Tembo et al. (2017); Midega et al. (2018). The findings from this study emphasize the importance of selecting resistant maize genotypes to minimize storage losses. Integrating effective pest detection methods, such as those highlighted by Saikia et al. (2010), could further aid in early detection and management of *S. cerealella* infestations, thereby reducing post-harvest losses and ensuring better grain quality. This studying was performed as a preliminary study in a control environment, future research should focus validating these findings under real-world storage conditions to enhance the practical application of resistant genotypes in integrated pest management strategies.

5.0 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. Notably, LNTP-Y recorded 16.65 adult emergence but exhibited 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 programs. Integrating these resistant genotypes into maize breeding efforts could significantly reduce storage losses, ensuring better grain quality and food security. However, future research 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.

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 performance of adult emergence of *Sitotroga cerelella* in maize Genotypes

GENOTYPES	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

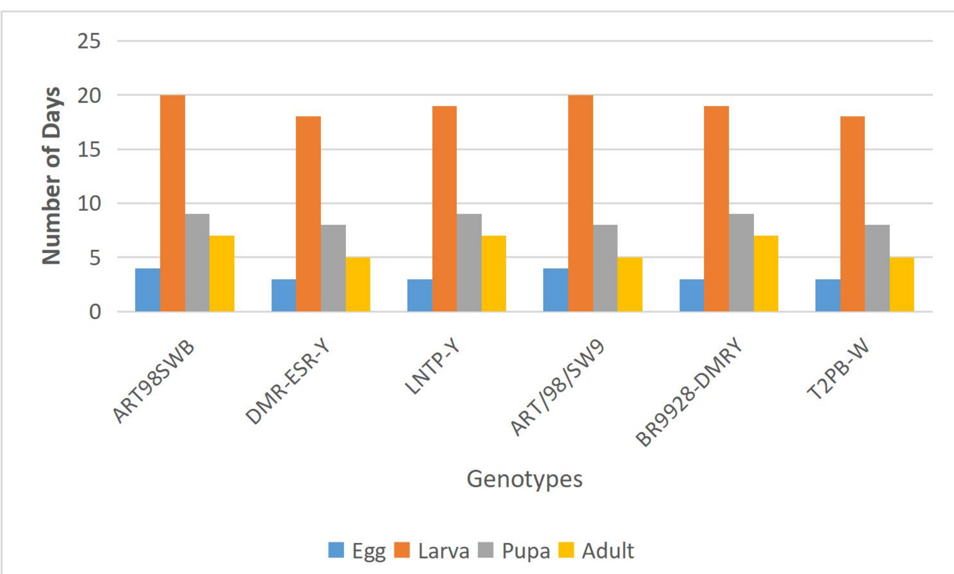

Figure 1: Developmental duration of *Sitotroga cerealella* across Maize Genotypes

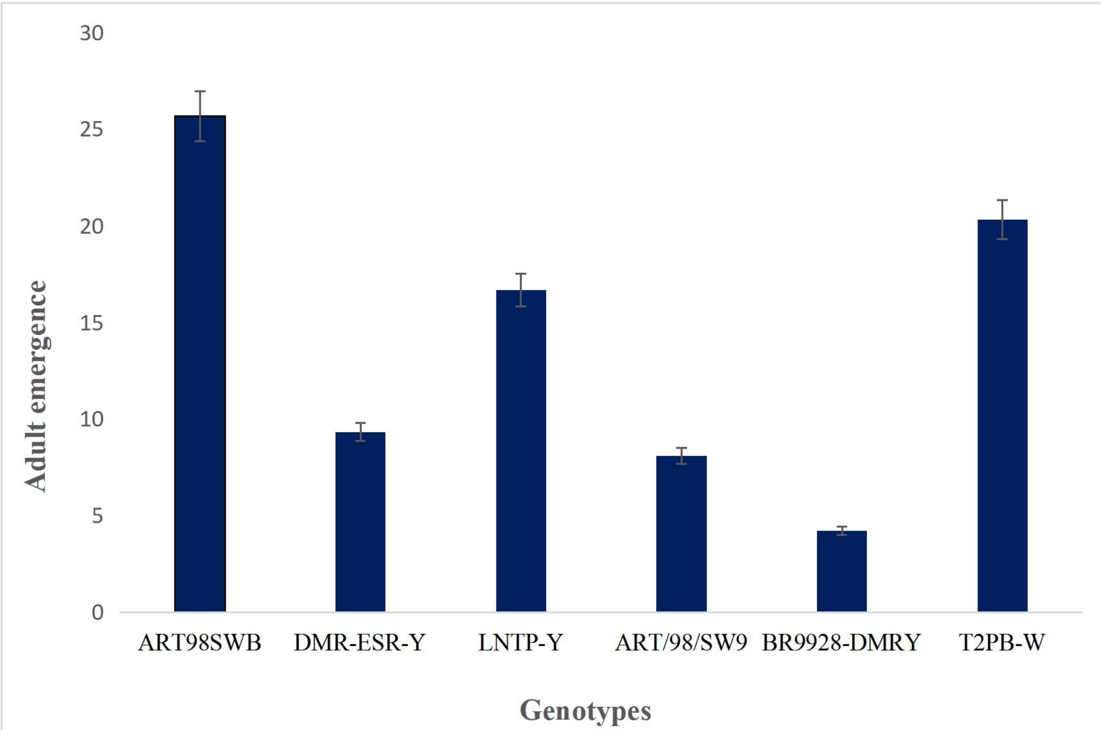

Figure 2. Adult Emergence of *Sitotroga cerelella* during maize Genotypes screening

Table 3: Percentage mean of damage grain per maize genotype

Genotypes	Mean score of damaged grains (%)
ART98SWB	20.00
DMR-ESR-Y	3.00
LNTP-Y	0.01
ART/98/SW9	4.33
BR9928-DMRY	8.67
T2PB-W	14.00

Table 4: Weight loss of maize grains due to *Sitotroga cerealella* infestation

Genotypes	Initial Weight (g)	Final Weight (g)	Weight Loss (g)	Percentage Weight Loss (%)
ART98SWB	261.52	208.68	52.84	20.20
DMR-ESR-Y	261.60	253.07	8.53	3.26
LNTP-Y	264.68	264.68	0.00	**0.00**
ART/98/SW9	264.64	252.70	11.94	4.51
BR9928-DMRY	264.61	238.37	26.24	9.92
T2PB-W	264.64	**225.31**	39.33	**14.86**

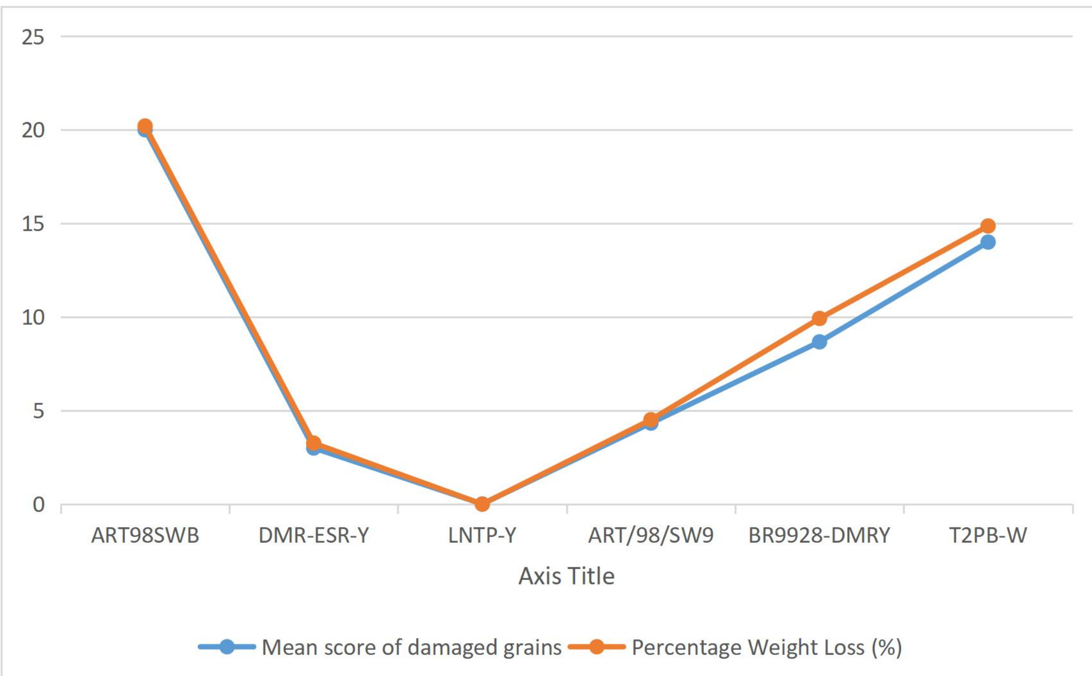

Figure 3: Correlation between damaged grains and percentage weight loss as a result of *Sitotroga cerealella* infestation.

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