

Title: GENETIC VARIABILITY OF EARLY MATURING INBRED MAIZE
LINE INFESTATION OF FALL ARMYWORM (*Spodoptera frugiperda* J.E.
Smith)

Course title: Bio 539- BIG DATA ANALYSIS

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INTRODUCTION.

Fall armyworm (*Spodoptera frugiperda*) has emerged as a significant threat to maize production in Africa since its introduction in 2016 (Goergen *et al.*, 2016a).. Fall armyworm is a pest of American origin that belong to the order Lepidoptera and family Noctuidae. It's existence has been reported to date back to the 17th century (Tijani, 2018).

LITERATURE REVIEW.

Previous studies have documented the devastating impact of fall armyworm on maize crops across Africa. Research efforts have focused on various control measures including cultural practices, biological control, chemical applications, and host-plant resistance. Host-plant resistance has gained attention as a sustainable management strategy. Genetic

studies have identified quantitative trait loci (QTL) associated with fall armyworm resistance, providing a foundation for breeding programs. l.

MATERIALS AND METHODS.

Sixteen early maturing white maize inbred lines with different levels of resistance to FAW that constituted the genetic material for this study were obtained from the maize improvement program of IITA. The study utilized 72 hybrids derived from crosses between selected inbred lines. Field trials were conducted at two locations: Ile-Ife and Ikenne, Nigeria, during 2023. The experimental design consisted of a randomized complete block design with three replications per environment. Treatments included both infested and non-infested conditions.

Data was collected on several agronomic traits including days to anthesis, days to silking, plant height, ear height, ears per plant, and grain yield. Fall armyworm damage was assessed using multiple parameters. Statistical analysis included combined analysis of variance (ANOVA), estimation of genetic parameters, and correlation and regression analyses to assess relationships between agronomic traits and fall armyworm (FAW) resistance. Stability analysis using coefficient of variation (CV) and visualization tools such as violin plots, scatter plots, and lollipop charts were employed to evaluate hybrid performance across infested and non-infested environments. Multi-trait selection criteria were applied to identify promising hybrids that combine FAW resistance with desirable agronomic traits, such as grain yield and plant height.

The methodology facilitated a comprehensive evaluation of genotype-by-environment interactions, enabling the identification of stable performers under varying infestation scenarios. This approach provides valuable insights into the genetic variability of FAW resistance and its association with key agronomic traits in early maturing maize germplasm.

RESULTS.

Table 1

term	df	sumsq	meansq	statistic	p.value
hybrid	63	108.84	1.7276	2.34	2.48E-05
env_label	1	1.41	1.4102	1.91	0.169
hybrid:env_	63	42.84	0.68	0.921	0.637
Residuals	128	94.5	0.7383	NA	NA

The analysis of variance reveals strong evidence of genetic variability among hybrids for the trait being studied, indicating that some hybrids perform better than others; however, the environment (infested vs. controlled) does not significantly influence the trait, suggesting that hybrids respond similarly across conditions, and the lack of significant interaction between hybrids and environments implies that hybrid rankings remain consistent regardless of environmental conditions.

table 2:

Parent	GCA_Effect_EASP_Control	GCA_Effect_EASP_Infested	GCA_Effect_EASP_Low
1	-0.002343657	-0.002343657	-0.100751714
2	-0.002343657	-0.002343657	-0.085168323
3	0.133189843	0.133189843	0.05806138
4	-0.110770456	-0.110770456	-0.189934374
5	-0.215646924	-0.215646924	-0.290990535
6	0.163846874	0.163846874	0.108357004
7	-0.107220125	-0.107220125	-0.173396589
8	-0.025900025	-0.025900025	-0.110488734
9	0.122104849	0.122104849	0.026656209
10	-0.14896215	-0.14896215	-0.247503941
11	0.094998149	0.094998149	0.003353771
12	0.040784749	0.040784749	-0.009899668
13	0.034895657	0.034895657	-0.0461738
14	0.007788957	0.007788957	-0.083505451
15	0.170429157	0.170429157	0.085403714
16	-0.154851242	-0.154851242	-0.20610405

Table 2 highlights the General Combining Ability (GCA) effects of parents for fall armyworm resistance (EASP) under controlled and infested environments, with a combined measure (GCA_Effect_EASP_Low) ranking parents based on resistance; notable findings include

consistent performance by Parent 3 and Parent 14, making them promising for breeding programs, while Parent 5 shows susceptibility to FAW damage.

Fig 1:

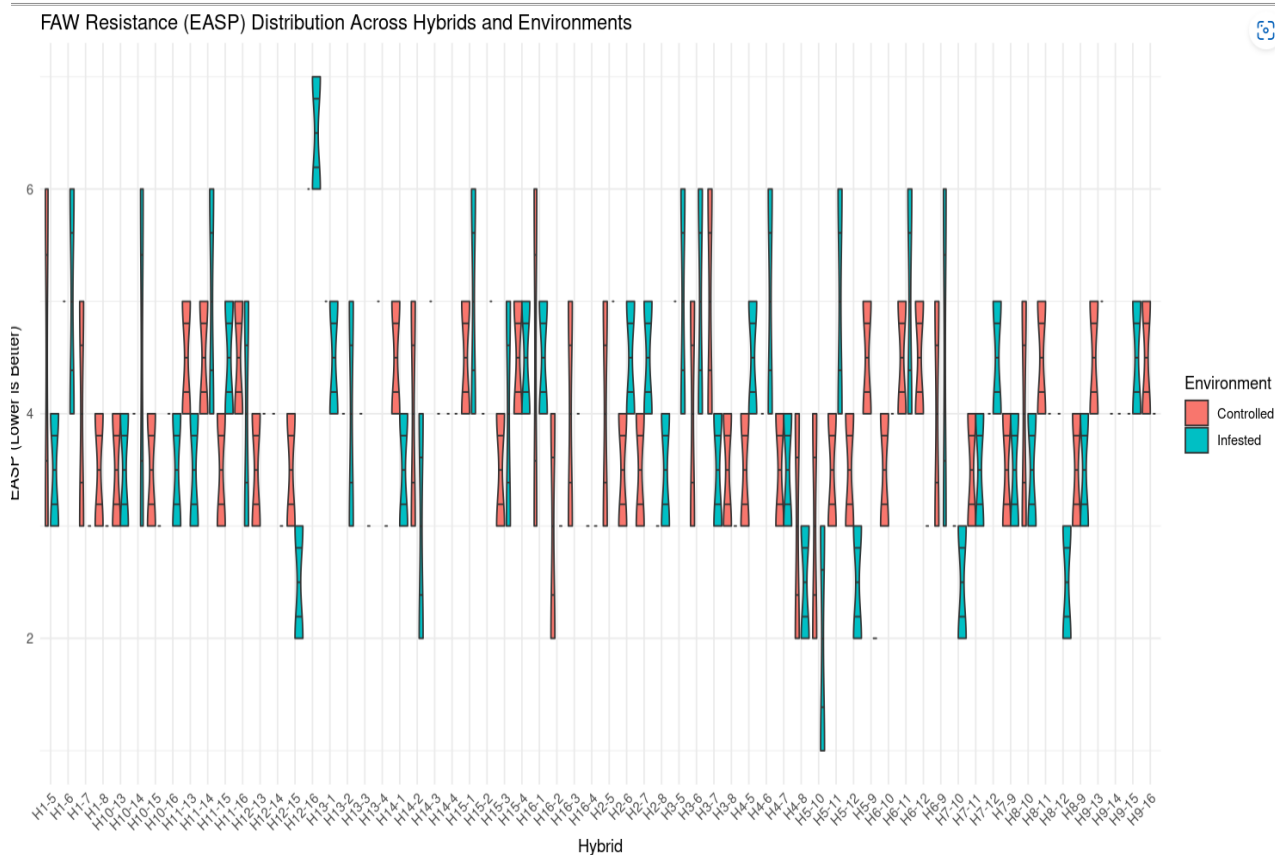


Fig 1 reveals significant genetic variability in FAW resistance (EASP) among maize hybrids, with higher EASP values in infested environments indicating greater susceptibility, while hybrids like H1_5, H10_3, and H16_2 consistently exhibit low EASP scores and stable performance across environments.

Fig 2 highlights that most parents exhibit consistent GCA effects for FAW resistance across control and infested environments, with notable performers like Parent 3 and Parent 14 showing robust resistance, while Parent 5 demonstrates susceptibility, emphasizing the importance of stability and genotype-by-environment interactions in selecting promising candidates for breeding programs.

Fig 2:
Comparison of GCA Effects for FAW Resistance Across Environments

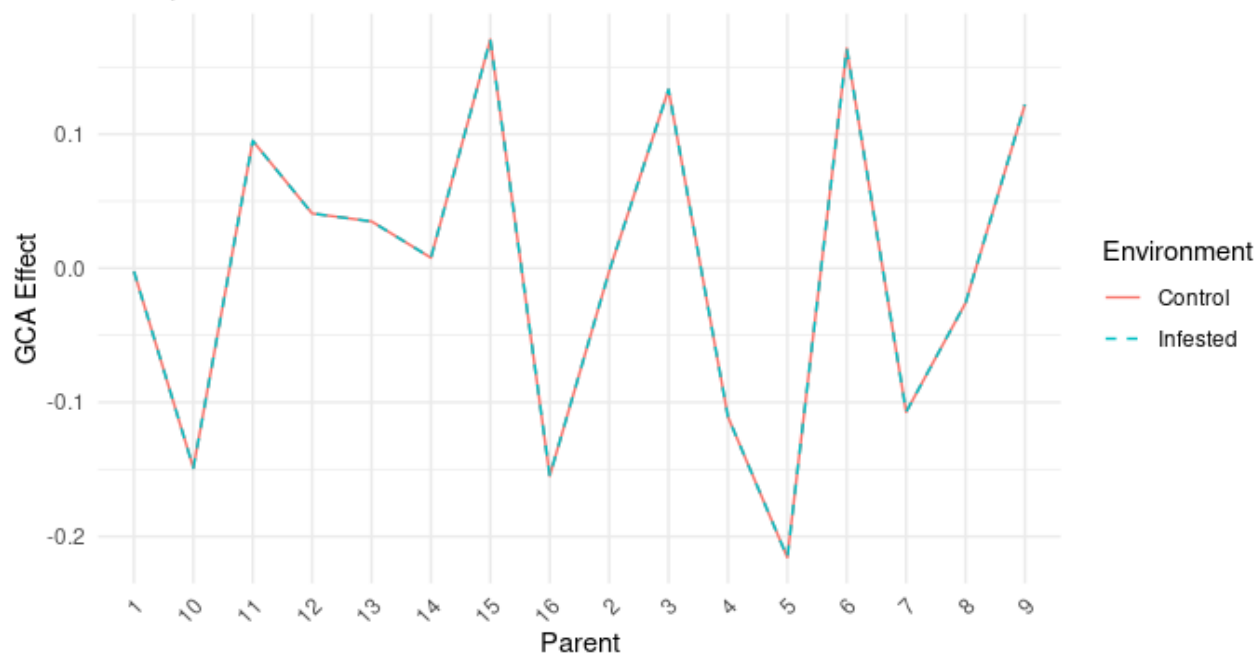


Fig 3:
Hybrid Performance: FAW Resistance vs. Grain Yield

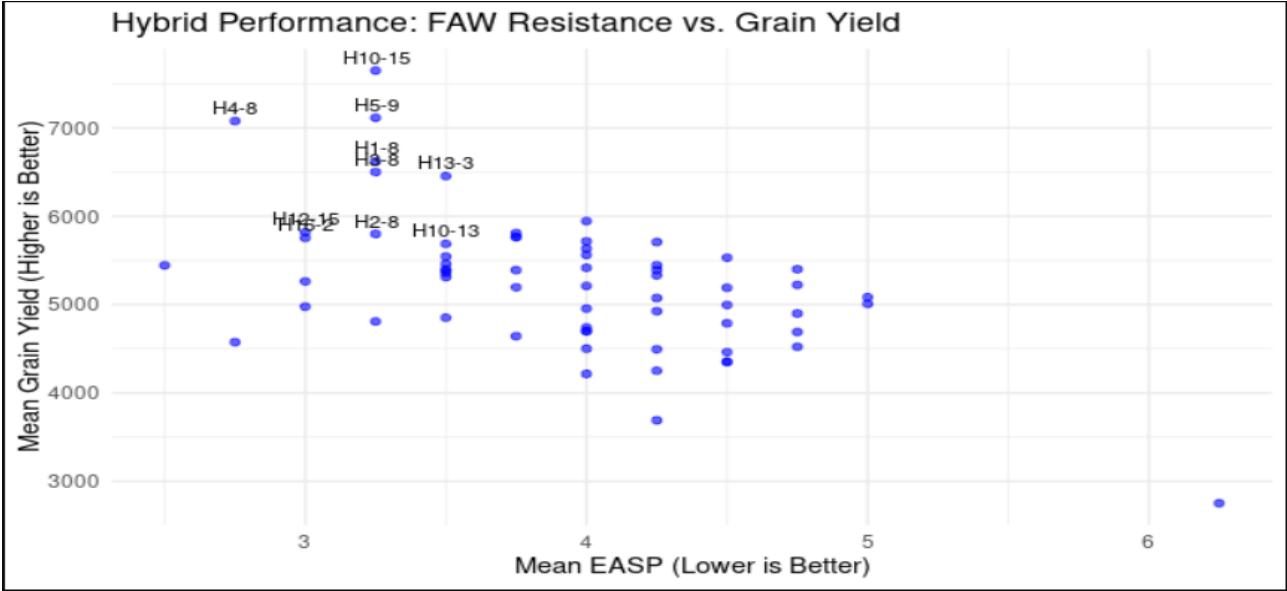


Fig 4:

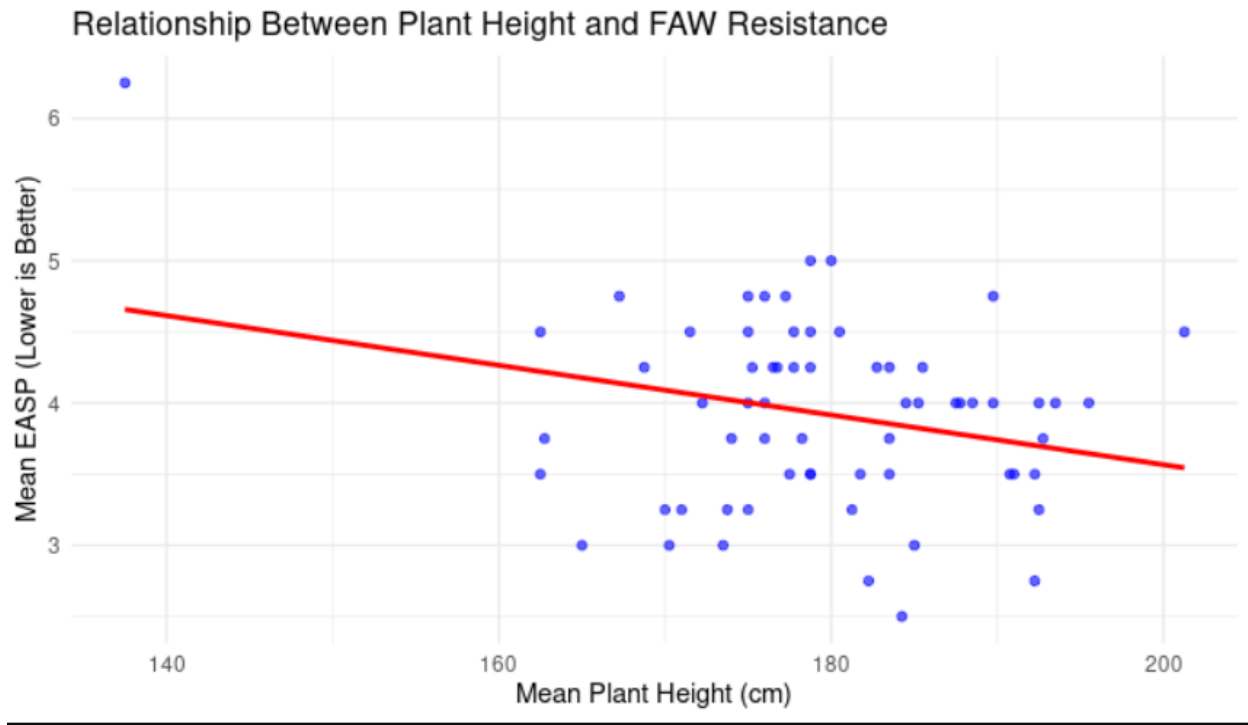
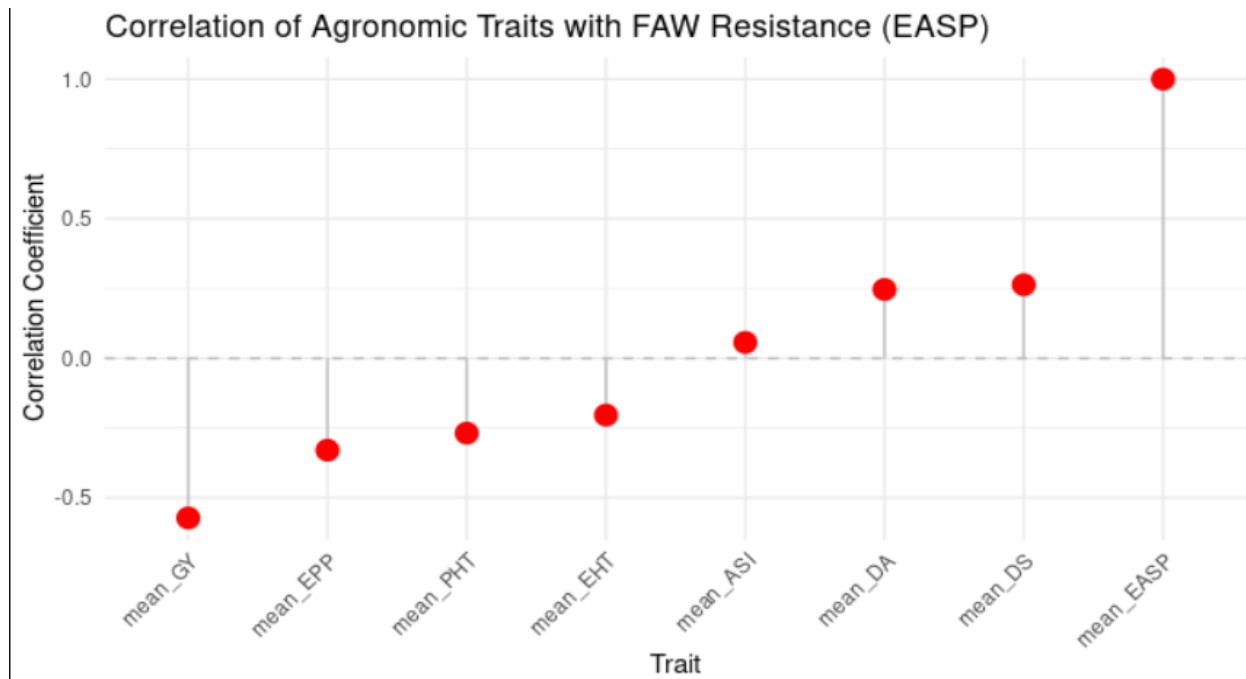


Fig 3 and 4 reveal a negative correlation between plant height and FAW resistance, with taller plants showing better resistance, and identifies promising hybrids like H4-8, H10-9, and H13-3 that combine low EASP values (high resistance) with high grain yields, offering potential for breeding programs to improve both traits simultaneously.

Fig 5 shows the mean grain yield exhibits a strong negative correlation with **EASP**, indicating that hybrids with higher grain yield tend to have better FAW resistance. Notable positive correlations are observed for traits like **EHT** (mean ear height), **AS** (mean anthesis-silking interval), and **DS** (mean days to silking). Traits such as **PHT** (mean plant height) and **DA** (mean days to anthesis) show no significant correlation with **EASP**.

Fig 5:



DISCUSSION

From the finding in this study, the sixteen inbred maize line evaluated differed significantly for all yield and relative traits and this indicate that there is presence of variation among the trait. The GCA highlights significant genetic variability for FAW resistance among maize parents, with consistent performers like Parent 3 and Parent 14 showing promise for breeding programs, while the combined measure offers a practical tool for ranking parental lines; further research should validate these findings across environments and explore genomic approaches to enhance resistance through marker-assisted selection

Hybrids with consistently low EASP values (e.g., H1_5, H10_3) can be used as prime candidates for breeding programs due to their robust FAW resistance, emphasizing the need for multi-environment trials, genomic approaches, and further field validation to develop resilient maize varieties and enhance food security in regions affected by fall armyworms. demonstrating strong resistance and making them promising candidates for breeding programs aimed at improving FAW tolerance. the genetic basis for FAW resistance is relatively stable across environments, emphasizing the importance of selecting parents like hybrid 3 and 14 with consistent GCA effects for breeding programs, while also underscoring the need to explore genotype-by-environment interactions, environmental

factors, and genomic approaches to enhance resistance and ensure broad adaptability in maize hybrids.

Top-performing hybrids like H4-8, H10-9, and H13-3 demonstrate strong resistance and high grain yield, emphasizing the need for multi-trait selection strategies, further validation across environments, and genomic approaches to enhance breeding programs aimed at developing resilient maize line. The correlation between grain yield and EASP suggests that high-yielding hybrids may also exhibit better resistance to FAW. By prioritizing hybrids with favorable trait combinations, breeders can develop maize varieties better equipped to withstand fall armyworm challenges. Further validation in multi-environment trials and exploration of the genetic basis of these traits can enhance the reliability and applicability of the findings.

REFERENCES.

Goergen, G., Kumar, P. L., Sankung, S. B., Togola, A., and Tamò, M. (2016a). First report of outbreaks of the fall armyworm *Spodoptera frugiperda* (J E Smith) (Lepidoptera, Noctuidae), a new alien invasive pest in West and Central Africa. *PLoS ONE*, 11(10). <https://doi.org/10.1371/journal.pone.0165632>