Original Research Article

Evaluation of Maize Varieties for Resistance to Field Pests: Fall Armyworm (*spodopterafrugiperda*je smith) and Stem Borer in a Tropical Rainforest Location

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ABSTRACT

Aims: To evaluate newly improved maize varieties for fall armyworm and stem borer~~s~~ resistance and determine the relationship among traits for increased productivity in a rainforest location ~~of~~ inNigeria.

Study Design: The experiments were laid out in a 10 x 10 triple lattice design with three replications and Randomized Complete Block Design (RCBD) in four replicates.

Place and Duration of Study: Field experiments were conducted during the late seasons of 2018 and 2019 at ObafemiAwolowo University Teaching and Research Farm, Ile Ife, Osun State, Nigeria.

Methodology: Hundred newly improved maize varieties were evaluated during the late season of 2018 for fall armyworm resistance, while ten stem borers resistant varieties were evaluated during the late season of 2019. Data were collected on emergence, flowering, vegetative, armyworm, and grain yield traits. Data collected were subjected to analysis of variance (ANOVA), descriptive statistics, correlation and cluster Analysis.

Results: Differential responses for resistance to fall armyworm traits were observed for all the varieties evaluated. Fall armyworm trait was observed to be negatively correlated with emergence percentage and ear number and positively correlated with flowering traits and moisture content. Furthermore, the results from the stem borer varieties evaluation indicated varietal differences for emergence percentage, plant height, ear height and kernel number. Stand count, ear number and weight per plot, moisture content had a significant positive correlation with yield while days to tasseling and silking and kernel row number had a significant negative correlation with yield.

Conclusion: The best resistant varieties to fall armyworm were F2SCA 1413-36, ACR. 06 TZL COMP. 3C_4 and 2013 TZEE-W POP STR with 6.01 tons/ha, 5.11 tons/ha, and 4.87 tons/ha of yield respectively while that of stem borer were TZBR Comp 1 –W C2 and Ama TZBR-W C4 with grain yield of 3.7 tons/hectare and 3.5 tons/hectare respectively.

Keywords: Biotic; Control; Insect; Pest; Productivity; Screening; Stress

1. INTRODUCTION

Maize is a staple cereal crop grown almost in all parts of the world. It is a high- yielding cereal grown successfully ~~under~~ in arain-fed environment and requires less capital. Nigeria produces 8 million tons of maize [1], giving Nigeria a leading step in corn production within ~~the~~ sub-Saharan Africa (SSA). Onuk*et al*.[2] noted that maize is one of the most abundant food crops in Nigeria; about 80% is consumed by man and animals while 20% is utilized in variety of industrial processes for production of starch, oil, high fructose, corn sweetener, ethanol, cereal and alkaline, consisting of 71% starch, 9% protein and 4% oil on a dry weight basis.

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Despite the enormous economic importance of maize, its yields in Africa are highly affected by ~~an~~ a6array of biotic and abiotic stresses. Insect pests in the field, are among the most economically important biotic constraints in maize production. The most economically important insect pest of maize in Africa include the shock of fall armyworm infestation and stem borer. Fall Armyworm (FAW; *Spodopterafrugiperda* (JE Smith); Lepidoptera, Noctuidae) is an insect native to tropical and subtropical regions of the Americas. Its larval stage feeds on more than 80 plant species, including maize, rice, sorghum, millet, sugarcane, vegetable crops and cotton. FAW can cause significant yield losses if not well managed. It can have a

number of generations per year and the adult moth can fly up to 100 km per night. According to Georgen*et al.* [3], FAW was first detected in Central and Western Africa in early 2016 (Benin, Nigeria, Sao Tome and Principe, and Togo) and in whole of mainland Southern Africa (except Lesotho and the Island States), in Burkina Faso, Cabo Verde, Cameroon, Central African Republic, Gambia, Ghana, Guinea Bissau, Niger, Senegal, and Ethiopia, Burundi, Kenya, Rwanda, South Sudan, Uganda, and it is expected to spread further, probably beyond the African continent. Its modality of introduction, along with its ecological adaptation across Africa are still speculative. The effects of FAW infestation go far beyond reducing crop yields in a season. As maize plants do not produce viable tillers, they are less able to tolerate FAW attack than sorghum and pearl millet plants. The effect on kernel yields is therefore greater.
~~The sustainable~~ Sustainable maize production, especially in the developing world is threatened by various stresses, including insect pests such as stem borers [4]). The most relevant stem borer species associated with maize production in Nigeria are moths belonging to the families Noctuidae and Pyralidae, namely: the maize stalk borer (*Busseolafusca*Fuller), the pink stem borer (*Sesamiacalamistis*Hampson), the millet stem borer (*Acigonaignefusalis*Hampson) and the African sugar cane borer (*Eldanasaccharina*Walker); [5]. In fact, stem borers have been the most damaging group of insect pests in maize cultivation worldwide (CIMMYT 2000).
Nigeria is with nearly 8 million tons Africa's largest producer of maize [1] and stem borers caused 10-100% loss in maize grain yield [7]. However, Kakule*et al.*[8] reported that within Africa, damage to maize varies with locations/regions, with sub-Saharan Africa recording the highest population of stem borers being directly correlated with damage and grain yield. The pests bore into the stem and cause dead heart symptoms, which results in the development of profuse number of tillers with unproductive spikes. Crop losses and grain yield reduction may result from the damage caused to growing pints leading to loss of stands (dead heart), damage to leaf (window pane) stem tunneling, hole (as portal of entry to secondary rot organisms), stem lodging, stem breakage, tassel and direct damage to ear shank and ear [7]. However, the consequence on yield is variable and depends upon sowing, borer species composition and abundance as well as insecticide treatment [9, 10, 4]. It has beenobserved that early-planted maize suffers less from borer attacks than late-planted maize. Late attack results in peduncle damage and plant breakage contributing to loss of grains and fodder.
There are four general approaches to insect control: chemical control (application of insecticides); biological control (identifying and introducing natural enemies of the pests into an area); crop management (a broad range of field and crop management techniques); and host plant resistance (HPR), by which the plant offers its ~~own~~ resistances to the insects. Chemical control is the most commonly used and most effective at farm level. Different insecticides have been recommended for the control of maize pests although these insecticides are not accessible to small-scale farmers. An alternative strategy is to use HPR. HPR uses conventional plant breeding to impart resistance to FAW and stem borer, it is therefore, the easiest control method for subsistence farmers, as well as the most environmentally safe. Although there are newly improved open pollinating varieties but presently, no validated report on their resistance to FAW and little report on resistance to stem borer in Africa. Therefore, the objectives of this study were to evaluate the response of newly improved maize varieties to fall armyworm and stem borer and determine the relationship among traits for increased productivity in a rainforest location.

2. MATERIAL AND METHODS

There were two experiments for this study:

Screening of maize varieties to fall armyworm: Field experiment was conducted during the late season of 2018 at ObafemiAwolowo University Teaching and Research Farm, Ile Ife, Osun State (7°28'N 4° 33'E, annual rainfall 1150 mm and altitude 244m above the sea level). The trial was planted on August 15, 2018 in which the treatments comprised of one hundred newly developed open pollinated varieties of extra early, early and late maturing maize obtained from the maize breeding program of International Institute of Tropical Agriculture (IITA), Ibadan. The varieties were laid out in a 10 x 10 triple lattice design with three replications. The plot consisted of a row of 5 m long, spaced 0.75 m apart with a spacing of 0.5 m within row. Three seeds were planted per hill and the plants were thinned to two at the

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three-leaf stage, giving a population of 53,333 plants/ha. Ploughing and harrowing were done before laying out of experimental field and the seeds were treated with Apron plus prior to planting. NPK fertilizer (60 kg N_2, 30 kg P, 30 kg K) was applied at 5 weeks after planting to supplement the nutrients available in the soil. Weeds were controlled with pre-emergence and post emergence herbicide as atrazine and paraquat respectively. The atrazine was applied one day after planting at the rate of 5 litres/ha. Paraquat was applied five weeks after planting after the crop had established. Weed were also controlled by hand weeding during dry matter growth stage of the crop for ease of harvesting. Data were collected on emergence counts, flowering traits (days to 50% tasseling, pollen shed and silking), plant and ear heights, grain yield and yield components (ear number, ear weight, ear aspect, kernel moisture content, kernel rows number, ear diameter, ear length and shelling percentage) from each plot within each replication. Data were also collected on armyworm traits (percentage of defoliation and severity of defoliation at 28 and 56 days after planting). Varieties rating based on foliar damage by FAW foliar damage under FAW infestation was assessed by scoring each infested plant in a germplasm entry on a 1-9 scale [11], where highly resistant plants were rated with a 1 (no visible damage) and highly susceptible plants with a 9 (completely damaged).
All data collected were subjected to Analysis of Variance (ANOVA), Descriptive statistics, Pearson Correlation and Cluster Analysis. The data were statistically analyzed according to PROC GLM in SAS (SAS System\9.0).

Evaluation of Stem Borer Resistant Varieties: Ten Stem borer resistant maize varieties and two local checks were collected from the Maize Breeding Programme of International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. The seeds were planted at the Teaching and Research Farm (T&RF), ObafemiAwolowo University Ile-Ife, Nigeria. The field was ploughed and harrowed at two weeks interval before planting. Planting was done during the late rainy season; 15th August 2019. The experiment was laid out in a Randomized Complete Block Design of twelve varieties with four replicates. Each plot was made up of two rows, 5 m long each, with intra- and inter-row spacings of 0.5 m and 0.75 m respectively. The seeds were treated with apron plus (N–(2,6-Dimethylphenyl)-N-(Methoxyacetyl) Alamine Methyl ester) prior to planting in other to prevent fungi attack, three seeds were planted per hole which was later thinned to two after two weeks of planting. Pre-emergence herbicide, Primextra Gold Label was applied at the rate of 5 liters/ha to the plot one day after planting. NPK fertilizer was applied 60 kg N, 30 kg P_2O_5, 30 kg K_2O; Weeds were also controlled by hand weeding as necessary after the crop had established.
Data were collected from each plot on emergence traits (emergence percentage, emergence index and emergence rate index), flowering traits (days to tasseling, anthesis and silking), vegetative traits (Plant and ear heights), grain yield and yield components (ear number, ear weight, grain moisture content, ear length, ear diameter, kernel row number).

Statistical Analysis
All data were subjected to Analysis of Variance, Varietal differences for the traits taken were determined by Least Significant Difference (LSD) at 5% level of probability. Spearman Correlation Analysis was carried out among the traits taken to determine the relationship between the traits.

3. RESULTS AND DISCUSSION

The mean grain yield (3.56 tons/ha) obtained from the hundred improved maize varieties evaluated during late cropping season of 2018 (Table 1) was considerably good compared to average potential yield of 4 – 6 tons/ha of maize [12]. This might be due to ability of some varieties that are tolerant to armyworm infestation[Ref.]. Other traits were also averagely good and the large portion of variance of all traits was due to larger standard deviation from mean which suggested that some varieties had a greater level of resistance to fall armyworm than others which can however be due to chemical composition of the cell wall that contributes to leaf toughness [13]. This variability can also be attested to from the wider range observed for all the traits including the grain yield (Table 1). The coefficient of variation (CV) for all the traits were relatively low except for anthesis-silking interval (Table 1) which implies that the traits were stable. That is, the occurrence of differences among the varieties were due to differences in genetic composition and or heterogeneity of the soil from which they were planted. There are differences between days after planting for percentage of defoliation (Figure 1) and severity of defoliation (Figure 2), respectively. Percentage of defoliation and Severity of defoliation were higher at 28 days after planting than 56 days after planting which might be due to increased toughness of leaves which is a physical characteristic that has an effect on insect

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Table 1: Descriptive Statistics for all the traits evaluated on the hundred maize varieties during late cropping season of 2018

Variable	Mean	StdDev	Std Error	Variance	Min	Max	CV
YLD (t/ha)	3.56	0.88	0.09	0.78	1.38	6.01	24.81
E%	77.70	19.00	1.90	362.23	19.19	100	24.49
DAT	54.16	3.09	0.31	10.07	49.00	59.67	5.71
DSLK	55.26	3.17	0.32	0.39	48.67	61.67	5.74
ASI	1.09	0.63	0.06	0.39	-0.67	3.00	57.08
PASP	2.09	0.55	0.06	0.31	1.00	3.67	26.46
ENO	15.61	2.85	0.28	8.10	5.33	20.67	18.23
EWT	1.76	0.44	0.04	0.19	0.72	2.90	24.78
EA	3.19	0.76	0.08	0.58	1.33	5.00	23.87
MC	17.49	2.33	0.23	5.41	12.8	23.33	13.30
PHT	176.41	9.52	0.95	90.58	150.60	199.40	5.39
EHT	81.07	8.08	0.81	65.31	58.67	97.93	9.97
NKRs	13.88	0.75	0.07	0.56	12.67	16.00	5.37
NK/R	29.77	2.30	0.23	5.27	21.67	35.00	7.72
ED	4.29	0.43	0.04	0.19	3.64	7.92	10.07
ELT	14.18	1.10	0.11	1.21	10.98	16.88	7.75
%D/P(28)	46.51	10.31	1.03	106.25	21.82	75.84	22.16
SD/P(28)	3.89	0.86	0.09	0.75	1.50	6.00	22.18
%D/P(56)	44.36	12.08	1.21	145.96	20.59	78.33	27.24
SD/P(56)	3.80	0.78	0.08	0.60	2.00	5.67	20.44

Where E% = Emergence percentage, DAT = Days to 50% Anthesis, DSLK = Days to 50% Silking, ASI = Anthesis-Silking Interval, PASP = Plant Aspect, PHT = Plant Height, EHT = Ear Height, ENO = Ear number, EWT = Ear Weight (kg), EA = Ear Aspect, MC = Kernel Moisture Content, NKRs = Number of Kernel Rows, NK/R = Number of Kernel/Row, ED = Ear Diameter (cm), ELT = Ear Length (cm), SH% = Shelling percentage, YLD = Grain Yield (t/ha), %D/P (28) and %D/P (56) = Defoliation percentage per plot at 28 and 56 days after planting, SD/P (28) and SD/P (56) = Severity of Defoliation per Plot at 28 and 56 days after planting, StdDev = Standard Deviation, Std Error = Standard Error, Min = Minimum, Max = Maximum, CV = Coefficient of Variability.

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penetration, preventing their piercing and sucking mouthparts from damaging plant tissues as reported by [13], which implies that the FAW infestation was at its peak during the early stage of growth. This agreed ~~was in consonance~~ with [14], who reported that studies have shown that maize response to FAW damage is growth-stage specific and dependent on the nutritional and water-balance status of plant.

Figure3 showed the cluster analysis of the 100 maize varieties using the traits that showed variations among the varieties. The hundred varieties were classified into 4 clusters based on similarities among the traits (Figure 3). Cluster 1 comprised of 62 varieties with similar characteristics, cluster 2 comprised of 32 varieties that are closely related and cluster 3 and 4 had 5 and 1 varieties respectively. This is an indication that the varieties in each cluster are the most closely related among the hundred varieties evaluated.

Correlations among the flowering, vegetative, grain yield (tons/ha), yield components and percentage defoliation, severity of defoliation of the hundred maize varieties evaluated for fall armyworm resistance during late cropping season of 2018 are presented in Table 2. Percentage defoliation 56 days after planting was observed to be negatively correlated ($P<0.01$) with emergence percentage and ear number (Table 2). This implied that the larger the number of the plants that emerged and grew to maturity to produce large number of the ears, the less the percentage defoliation 56 days after planting as expected. Severity of defoliation 56 days after planting was also observed to be positively correlated ($P<0.05$) with days to anthesis and silking as well as moisture content (Table 2).This indicated that the earlier the maize varieties flower, the less the severity of defoliation 56 days after planting and the later the maize varieties flower the more the severity of defoliation 56 days after planting. The less the moisture content at harvest the more the defoliation 56 days after planting. There was significant positive correlation at 0.01 and 0.05 levels of probability between the grain yield and most other traits taken except for plant and ear aspect that were negatively correlated at 0.05 and 0.01 levels of probability (Table 2). This implies that as those positively correlated traits increases, the grain yield would increase while the negatively corrected traits would inversely reduce the grain yield if they are selected. This is in corroboration with the findings of Bello and Olaoye[15].

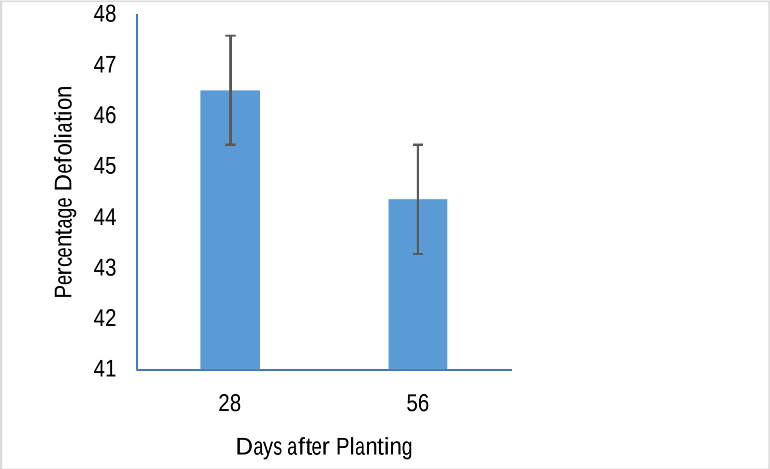

Figure 1: Effect of Days after planting on thePercent defoliation of the maize varieties evaluated during the late cropping season of 2018.

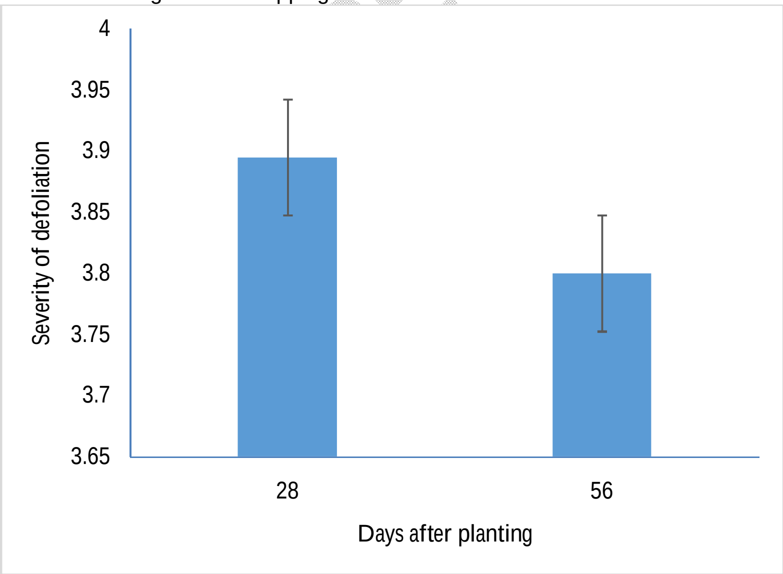

Figure 2: Effect of days after planting on theseverity of defoliation of the maize varieties evaluated during the late cropping season of 2018.

The results from the stem borer resistant varieties trial indicated that varieties; TZBR Eld. -4-W C2, Ama TZBR-W C4, Ama TZBR-Y C1, TZBR Comp 2-Y C3, BR LNTP-YC6, TZBR Comp 1 –W C2 and TZBR Comp 2- WC2 had the highest emergence percentage and were not significantly different from each other but were significantly different from the rest of the varieties (Table 3).
Varieties Ama TZBR-W C4, TZBR Comp 2-Y C3 and CHECK 2 were the tallest which were not significantly different from each other but different from the other varieties (Table 3). Finally, varieties Ama TZBR-W C4, TZBR Comp 2-Y C3 and CHECK 2 had the highest ear heights which were not different from each other but also different from the rest of the varieties (Table 3). Varieties; TZBR Comp 1 –W C2 and TZBR Comp 2-Y C3 were among the highest yielding varieties while TZBR Eld. -4-W C2 and the local check 1 were the poorest yielding varieties from this study (Table 3).
Spearman Correlations among the traits evaluated from the Fall armyworm resistance field trial were presented in Table 4. Emergence percent was observed to be negatively correlated and positively correlated with emergence rate index (P<0.01) and stand count (P<0.05) respectively (Table 4). Emergence index was also observed to be positively correlated (P<0.05) with plant and ear heights (Table 4). Emergence rate index (ERI) was also observed to be negatively correlated (P<0.05) with stand count. Stand counts of the maize varieties evaluated were positively correlated with plant height, ear height (P<0.01), ear weight (P<0.0.01), ear number (P<0.05), moisture content(P<0.05) and yield (P<0.01) while days to silking was negatively correlated with stand count (Table 4). Grain yield was positively correlated with stand count, plant height, ear weight, ear number, moisture content and kernel row number while significant negative correlations were obtained between grain yield and days to taselling and silking (Table 4). This is in agreement with the findings ofNemati*et al*. [16].

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4. CONCLUSION

It was concluded from the fall armyworm resistant varietal trial that differential responses for resistance to fall armyworm traits were observed for all the varieties evaluated which were further characterized into four different clusters in which cluster 1 comprised of sixty-two varieties, cluster 2 comprised of thirty-two varieties, five varieties in cluster 3, and finally just one variety in cluster 4. TZE-W POP DT STR QPM C_O, TZE-Y DT STR C_4, ACR. 06 TZL COMP. $3C_4$, F2SCA 1413-36 and 2013 TZEE-W POP STR C_5 were identified as the best resistant varieties to fall armyworm with 20.6%, 20.8%, 22.4%, 23.2% and 26.3% of defoliation respectively, at 56 days after planting and 3.13 tons/ha, 4.81 tons/ha, 5.11 tons/ha, 6.01 tons/ha and 4.87 tons/ha of yield respectively. Positive relationship was observed among the fall armyworms resistance traits and flowering and moisture content traits while negative relationship was obtained from the armyworm traits with emergence and ear number.
From the experiment of stem borer resistant maize varieties trial, TZBR Eld. -4-WC2, had the highest emergence percentage, TZBR Comp 2-Y C3, had the highest plant and ear heights while all the varieties had high kernel row number except for Ama TZBR-W C4 and BR LNTP-YC8. The yield of the 12 maize varieties ranged from 2.1 – 3.7 tons/hectare with the yield of TZBR Comp 1 –W C2 (3.7 tons/hectares) among the highest yielding varieties while one of the local checks varieties having the least yield of 2.0 tons/hectare. Stand count, plant height, ear weight, ear number and moisture content had positive relationship with yield while days to tasseling and kernel row number had negative relationship with yield.

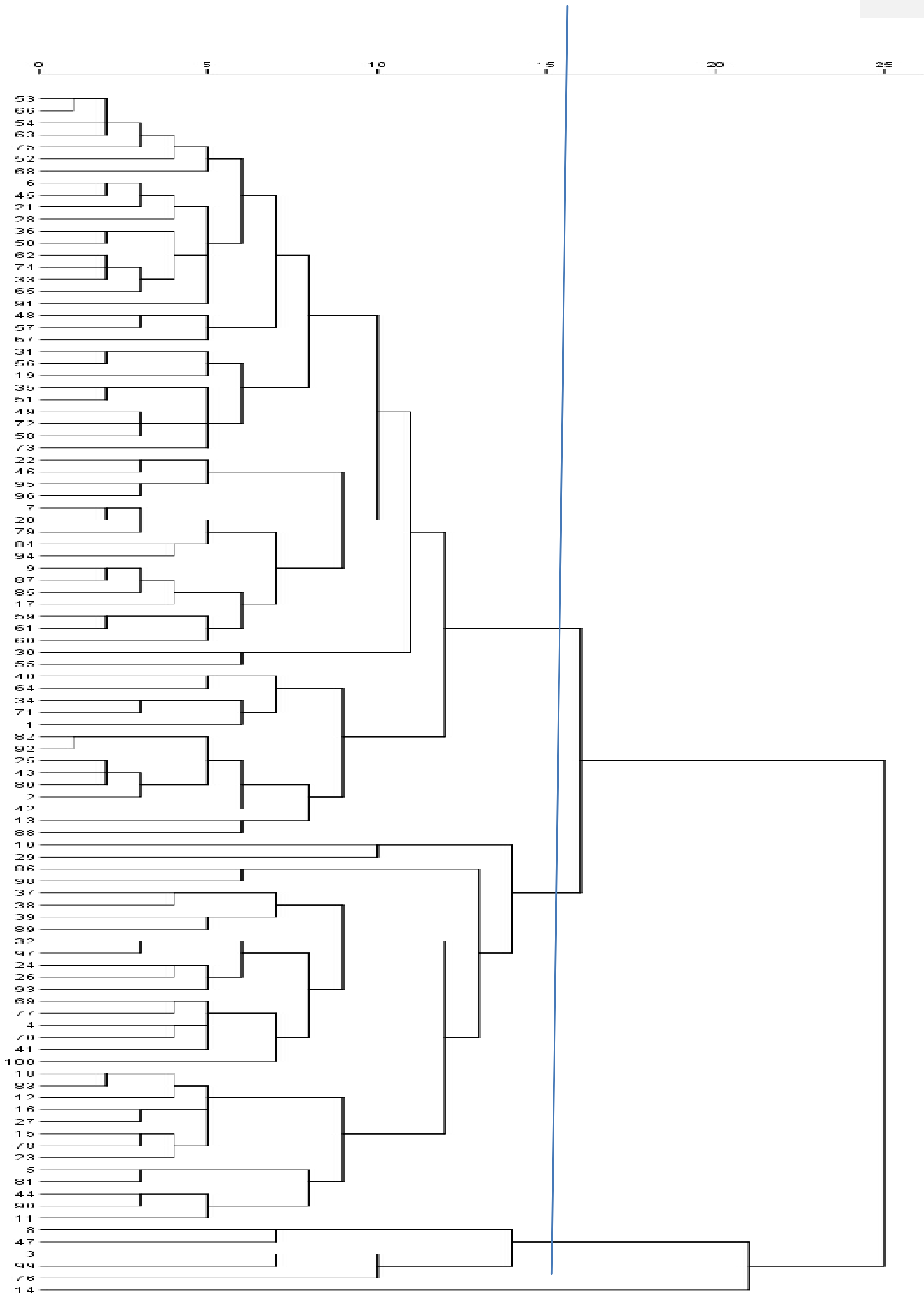

Figure 3: Cluster analysis of hundred maize germplasm evaluated during the late cropping season of 2018.

Table 2: Pearson's correlation among the flowering, vegetative and armyworm scoring traits, grain yield (tons/ha) and yield components of the hundred evaluated maize germplasm during late cropping season of 2018

	YLD (t/ha)	E%	DAT	DSLK	ASI	PASP	ENO	EWT (kg)	EASP	MC	PHT (cm)	EHT (cm)	NKRs	NK/R	ED (cm)	ELT (cm)	%D (28)	SD/P (28)	%D (56)	SD/P (56)
YLD (t/ha)	1.00																			
E%	0.45**	1.00																		
DAT	0.05	0.17	1.00																	
DSLK	0.04	0.22*	0.98**	1.00																
ASI	-0.02	0.30**	0.03	0.23*	1.00															
PASP	-0.25*	0.07	0.22*	0.25*	0.21*	1.00														
ENO	0.75**	0.71**	0.03	0.05	0.11	-0.11	1.00													
EWT (cm)	0.93**	0.43**	0.17	0.16	-0.06	-0.25*	0.74**	1.00												
EASP	-0.52**	0.19	0.002	0.04	0.18	0.34**	-0.07	-0.57**	1.00											
MC	0.30**	0.20	0.83**	0.82**	0.07	0.06	0.17	0.46**	-0.26**	1.00										
PHT (cm)	0.48**	0.15	0.39**	0.38**	0.01	-0.22*	0.27**	0.52**	-0.33**	0.46**	1.00									
EHT (cm)	0.45**	0.33**	0.58**	0.58**	0.05	-0.02	0.35**	0.48**	-0.18	0.55**	0.80**	1.00								
NKRs	0.25**	0.14	0.21*	0.22*	0.04	0.05	0.18	0.30**	-0.06	0.32**	0.14	0.17	1.00							
NK/R	0.35**	-0.09	-0.07	-0.13	-0.30**	-0.31**	0.07	0.36**	-0.57**	0.06	0.30**	0.17	-0.09	1.00						
ED	0.29**	0.10	0.26**	0.25*	-0.04	-0.20	0.21*	0.28**	-0.27**	0.26**	0.28**	0.23*	0.11	0.15	1.00					
ELT	0.40**	-0.06	0.03	-0.20	-0.23*	-0.22**	0.11	0.46**	-0.65**	0.26**	0.44**	0.25	-0.06	0.75**	0.23*	1.00				
%D (28)	0.04	0.09	-0.03	-0.03	-0.05	-0.03	0.15	0.05	0.01	-0.02	0.03	0.06	0.13	0.02	0.06	0.05	1.00			
SD/P (28)	0.04	0.16	0.09	0.10	0.08	0.10	0.11	0.06	0.05	0.10	0.01	0.03	0.19	-0.10	0.11	-0.08	0.62**	1.00		
%D (56)	-0.14	-0.40**	0.09	0.05	-0.18	0.06	-0.32**	-0.11	-0.14	0.09	-0.10	-0.10	0.02	-0.05	0.08	-0.02	0.23	0.22	1.00	
SD/P (56)	0.03	0.05	0.25*	0.25*	0.05	0.18	0.02	0.06	0.01	0.25*	-0.07	0.05	0.17	-0.09	0.14	-0.06	0.38**	0.52**	0.59*	1.00

Table 3: Varietal differences between three traits of stem borer resistance maize varieties on Teaching and Research Farm, OAU, during the late season of 2019.

VAR	EPCT	PHT	EHT	YLD
TZBR Eld. -4-W C2	71.6	130.3	62.1	2.1
TZBR Eld.-4-Y C2	61.4	142.6	67.6	2.5
BR TZL Comp 4 DMRSR	43.9	145.3	59.9	2.7
Ama TZBR-W C4	68.6	152.8	72.2	3.5
Ama TZBR-Y C1	69.3	145.9	69.1	3.4
TZBR Comp 1-Y C3	60.2	141.9	67.9	2.3
TZBR Comp 2-Y C3	73.5	164.8	82.6	3.2
BR LNTP-YC6	65.5	132.7	62.4	2.8
TZBR Comp 1 –W C2	64.0	135.3	59.8	3.7
TZBR Comp 2- WC2	71.2	142.7	64.10	2.5
CHECK 1	44.3	134.2	55.3	2.0
CHECK 2	57.2	152.4	70.3	2.9
$LSD_{0.05}$	10.8	18.5	12.5	1.5

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Table 4: Spearman Correlations among traits measured for the stem borer resistant maize varieties evaluated during the late cropping season of 2019 at the Teaching and Research Farm, OAU, Ile-Ife.

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	EPCT	EI	ERI	STDC	DT	DA	DS	ASI	PLTH	EH	EW	EN	MC	EL	ED	KN
EI	0.33	-														
ERI	-0.86**	-0.05	-													
STDC	0.67*	0.57	-0.61*	-												
DT	0.03	-0.19	0.16	-0.56	-											
DA	-0.01	-0.39	-0.02	-0.49	0.59*	-										
DS	-0.05	-0.29	0.04	-0.64*	0.66*	0.64*	-									
ASI	0.13	0.13	-0.07	-0.09	-0.01	-0.37	-0.39	-								
PLTH	0.13	0.58*	-0.05	0.65*	-0.53	-0.50*	-0.46	0.07	-							
EH	0.41	0.62*	-0.28	0.76**	-0.59*	-0.41	-0.43	0.03	0.78**	-						
EW	0.25	0.37	-0.31	0.77**	-0.59*	-0.60*	-0.65*	-0.06	0.57	0.42	-					
EN	0.45	0.22	-0.48	0.65*	-0.18	-0.49	-0.29	0.16	0.38	0.29	0.79**	-				
MC	0.49	0.52	-0.34	0.69*	-0.04	-0.11	-0.30	-0.29	0.44	0.37	0.52*	0.43	-			
EL	0.03	-0.39	-0.24	0.07	-0.00	-0.13	-0.36	-0.24	-0.06	-0.31	0.12	0.19	0.19	-		
ED	-0.12	0.04	0.29	0.16	-0.07	-0.44	-0.37	-0.03	0.41	0.05	0.23	0.27	0.27	0.35	-	
KN	-0.27	-0.21	0.48	-0.71	0.74**	0.46	0.59*	0.08	-0.32	-0.38	-0.83**	-0.59*	-0.58*	-0.18	0.18	-
YD	0.25	0.37	-0.31	0.77**	-0.59*	-0.60	-0.65*	-0.06	0.57*	0.42	0.99**	0.79**	0.79**	0.12	0.23	0.83**

*, ** Significant at 0.05, 0.01 levels of probability respectively.

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