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Infestation of Sugarcane Accessions by *Eldana saccharina* Walker (Lepidoptera: Pyralidae) at Calabar, in the Rainforest Zone of Nigeria

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ABSTRACT: Twelve accessions of sugarcane namely AKWA-005,B61208, B79797,CO504, CO1001,CP65-357, DB37/45, EBON-006, F141, HAT4, IMO-002 and TRITON were exposed to natural infestation of the African stem borer (*Eldana saccharina* Walker) at Calabar in 2014 and 2015 cropping seasons and susceptibility to infestation evaluated using percentage bored and lodged stems, number of borer exit holes/infested stem, number of borers/infested stem, length of stem and number of stems/stool. Experimental design was Randomized Complete Block (RCB) with four treatment replications. The results showed that accessions AKWA-005, CO504, HAT4, and TRITON had significantly ($P<0.05$) higher percentages of bored and lodged stems, higher numbers of borer larvae and exit holes/infested stem, and longer tunnel length than other accessions. HAT4 had the shortest stem and the lowest number of stems/stool, differing significantly ($P<0.05$) from all other accessions. Relative to accessions B61208, B79797,CO1001, CP65-357, DB37/45, EBON-006, F141, and IMO-002, AKWA-005, CO504, HAT4, and TRITON are susceptible and should be replaced to mitigate *Eldana* damage to sugarcane in the area.

Keywords: Infestation, sugarcane accessions, *E. saccharina*, tunnel length, lodged stems, bored stems

INTRODUCTION

Sugarcane, *Saccharum officinarum* L., plant is a perennial grass that forms lateral shoots at the base to produce multiple stems, typically 3-4 metres high and about 5 cm in diameter (Perez, 1997). It is a source of energy for human beings and more recently a source of biodiesel, replacing fossil fuel for motor vehicles (You *et al.*, 2013). Sugarcane was first grown in South East Asia and Western India (Verheye, 2010) around 327 B.C. Its cultivation spread to Egypt around 647 A.D., Spain 755 A.D., and to nearly all tropical and sub-tropical countries of the world (Boyel, 2001). Worldwide sugarcane is planted on 20.42 million ha land area with a total production of 1333 million metric tons (Ramotra and Patil, 2015).

In Africa, important sugarcane producing countries are Mauritius, Kenya, Sudan, Zimbabwe, Ethiopia, Nigeria, Cameroon, and Zaire. Nigeria is one of the most important producers of the crop with a production of 1.06 million tonnes in 2014, up from 1.05 million tonnes in 2013, an increase of 1.16% (FAO, 2014).

In Nigeria's diverse agro-ecologies where sugarcane is grown, insect pests are major biotic constraint to production and lepidopterous stem borers, including the African stem borer (*Eldana saccharina* Walker), the spotted borer (*Chilopartellus* Swinhoe), (*Chilosachariphagus* Bojer) and the greater sugarcane borer (*Sesamia cretica* Lederer) are key field pests (Atkinson and Carnegie, 1989; Okweche *et al.*, 2013;

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Vreysen, 2010). They bore and tunnel within stems. Attack at the vegetative stage kills the growing points causing "deadhearts" and at a stage stem lodging/breakage, reduction in cane and sugar yield. *Eldana saccharina* occurs naturally in wetland sedges and indigenous grasses; it is limited in distribution to areas with warm temperatures and relatively high rainfall and it prefers dead leaf material for oviposition (Potgieter *et al.*, 2013).

The control of stem borers is largely by use of synthetic insecticides such as carbofuran and carbaryl (Dike *et. al.,* 1999; Miguel, 1993; Okweche *et al.*, 2010). Neem products offer desirable alternatives to using synthetic chemicals in agricultural systems where protection of the environment and preservation of beneficial organisms are important. Excessive usage of synthetic insecticides worldwide has evoked environmental and human health concerns and fostered research on safer, eco-friendly pest management alternatives including the use of varieties resistant to stem borers (Okweche *et al.*, 2013). It is well established that infestation of sugarcane stem borers results in huge economic losses and calls for effective search for varieties resistant to the pests (Ye *et al.*, 2016). Efforts at achieving this has led to breeding and production of genetically engineered stem borer-resistant varieties which have been reported by earlier workers including Weng *et al.*, (2006), Vargas *et al.*, (2015) and Ngwuta *et al.* (2015). There is paucity of reports based on empirical data in respect of stem borer-resistant varieties of sugarcane in Nigeria especially focusing on *E. saccharina* in the Rainforest zone where Calabar is located. This study assessed the level of infestation and damage caused by *E. saccharina* on some industrial sugarcane accessions in Calabar.

MATERIALS AND METHODS

The experiment was carried out at the Teaching and Research Farm, University of Calabar, Calabar (latitude 4.5" to 5.2" North and longitude 3.0" and 8.6" East) in 2014 and 2015 planting season. Annual total rainfall in the area ranged from 2,000 - 3,500 mm and the relative humidity ranged from 70-85 %. Four replications of 12 sugarcane accessions (Table 1), obtained from National Cereals Research Institute Badeggi (NCRI), Niger State, and the University of Ilorin Sugar Research Institute, Ilorin, Kwara State, were planted in randomized complete block design. Each plot measured 5 x 5 m and adjacent plots were separated by 2 m. Intra- and inter-row spacing were 1 m and 1.5 m, respectively.

Source of experimental materials

A total of twelve (12) industrial sugarcane accessions were evaluated to determine the level of infestation and damage by stem borers. The industrial sugarcane genotypes were obtained from the National Cereals Research Institute (NCRI) Badeggi-Niger State and the University of Ilorin Sugar Research Institute (USRI) Ilorin, Kwarra State. The sugarcane comprised of early, mid and late types of profusely and shy flowering industrial sugarcane (Table 1).

Experimental plot

The experiment was laid out in a randomized complete block design with three replications. The total land area was 44m x 23m including paths and each plot measured 25 square metres (5 m x 5 m), seed bed of 1m apart within row and an inter-row spacing of 1.5m and 2m path between plots separated by a 2 m path.

Data collection and analysis

Ten matured sugarcane accessions were randomly sampled from the middle rows in 2014 and 2015 in the month of November when infestation was at its peak. Data were collected on proportions of stems bored or lodged out of all the stems in a plot, number of entry per infested stem, number of borer larvae per infested stem, borer tunnel length. From the later, borer cavity units were derived using length of matured *E. Saccharina* larva using y/x where y = tunnel length and x = length of mature

E. saccharina. The total number of stem per stool and length of sugarcane stem were determined using a measuring tape. Borer larvae were identified using description in Polaszek (1998).

RESULTS AND DISCUSSION

Only *E. Saccharina* larvae were encountered in split infested stems. Borer density (Fig. 1), number of exit holes/stem (Fig. 2), percentage of stems lodged (Fig. 3), and number of borer cavity (Fig. 4) were significantly higher in AKWA-005, C0504, HAT4, and TRITON than in other accessions. There was no significant (P>0.05) difference between the accessions with the highest number of exit holes. However, significant (P>0.05) differences existed between some accessions with lower number of exit holes, percent lodged stems, and number of borer cavity. The higher level of infestations recorded on the above treatments equally resulted in a significant (P>0.05) increase in borer population per stalk (Figure 5). The effects of season on the various infestation and damage parameters are represented in Figure 6. The result showed that there was no significant difference between the parameters assessed in 2014 and 2015 cropping seasons.

Table 2 shows the effects of different sugar cane accessions on the number of stool and stalk length. C01001 had significantly longer stalk length compared with other treatments. HAT4 had significantly reduced stalk length, however, not significantly different from AKWA-005, C0504, and TRITON. Accessions C01001, B70707, CP65-357 and EBON-006 had significantly higher number of stools compared to other treatments. However, F141 and HAT4 had significantly lower number of stools.

The most widely used method of controlling stem borers is by the application of insecticides (Moyal, 1989, Okweche *et al.*, 2010). The study showed that *E. Saccharina* caused a reduction in susceptible sugarcane yield, which corroborates the findings of Way (2003). *Eldana saccharina* also impacted negatively on total number of stool per stalk for the highly susceptible accessions. Similar effects were reported for *C. sacchariphagus* in Reunion (Goebel *et al.*, 1999); however, the effect of this borer on stalk mass was more evident. The age at which the crop is attacked may influence biomass accumulation, as *E. Saccharina* characteristically attacks both young and old crops (Goebel *et al.*, 2005; Keeping *et al.*, 2014).

Sugarcane has been reported by many authors including Polaszek (1998) to be the primary host of *E. saccharina,* hence breakdown in resistance may occur when planted in *E. saccharina* endemic zone. Subsequent work by Keeping (2006) established a routine programme for screening sugarcane cultivars for *E. saccharina* resistance. Currently, cultivars such as N42, N41, N39, N33, N29 and N21 tend to be more resistant than cultivars such as N30, N27 and N26, which would not be recommended in situations where there is a high risk from *E.*

Table 1: **Characterization of the sugarcane accessions**

Accessions	Place of origin	Stalk girth(cm)	Stalk length(cm	Stalk colour (exposed)	Stalk colour (covered)	Internode length (cm)	Internode shape	Internode Alignment	Wax	Bud shape	Bud size	Bud Structure groove	
B61208	Barbados, WIND	-	-	-	-	-	-	-	-	-	-	-	-
C01001	Coimbatore, India	2.92	121.6	Purple green	NA	9.65	Conoidal	Straight	5	Flattened	Medium	Indicated	-
B70607	Barbados, WIND	3.06	151.6	Green	NA	14.17	Cylindrical	Straight	4	Flattened	Small	Indicated	-
F141	Faj, Puertorico	3.06	150.0	Purple green	NA	14.17	Cylindrical	Straight	5	Protruding	Small	Prominent	-
CP65-357	-	-	-	-	-	-	-	-	-	-	-	-	-
HAT-4	Not Known	3.03	216.7	Green	Green	10.71	Tumescent	Straight	5	Flattened	Medium	Absent	-
DB37 45	Not Known	-	-	-	-	-	-	-	-	-	-	-	-
IMO-002	Egbeada-Ohomi	2.80	120.0	Green purple	-	-	Cylindrical	Straight	-	-	-	-	-
EBON-006	Ohaozara, Nigeria	3.20	200.0	Green	-	-	Cylindrical	Straight	-	-	-	-	-
TRITON	Not Known	2.27	156.7	Yellow	Greenish yellow	13.39	Cylindrical	Zigzag	3	Flattened	Small	Absent	-
AKWA-005 12	Nungoku, Nigeria	2.80	120.0	Purple yellow	-	-	Cylindrical	-	-	-	-	-	-
C0504	Coimbatore, India												

Internode wax
1-Absent
2-Restricted to the wax band
3-Light, restricted to upper half of the internode
4-Light throughout the internode
5-Heavy throughout the internode

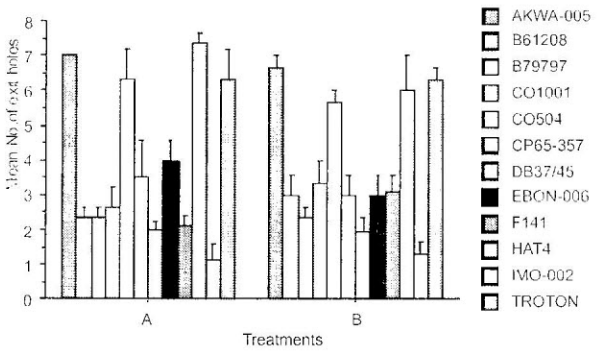

Figure 1: **Effects of sugarcane accessions on number of exit holes; A=2014, B=2015**

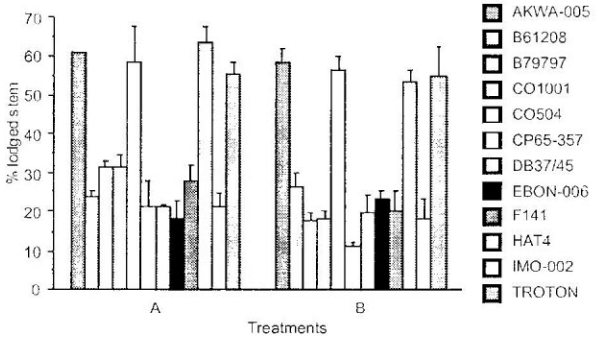

Figure 2: **Effects of sugarcane accessions on percentage lodged stem; A=2014, B=2015**

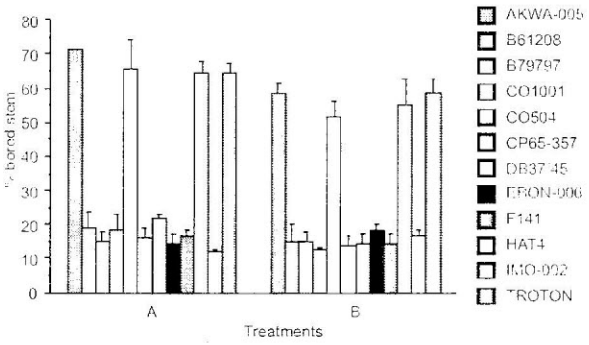

Figure 3: **Effects of sugarcane accessions on percentage bored stem; A=2014, B=2015**

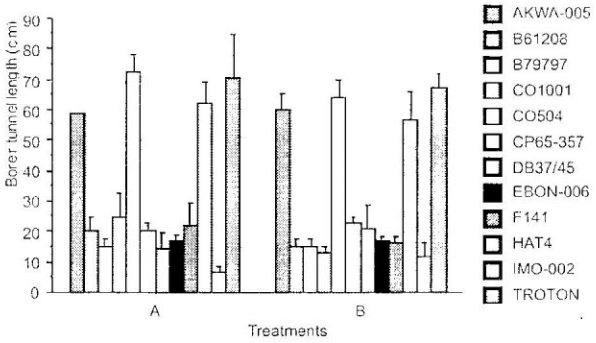

Figure 4: **Effects of sugarcane accessions on borer tunnel length;A=2014, B=2015**

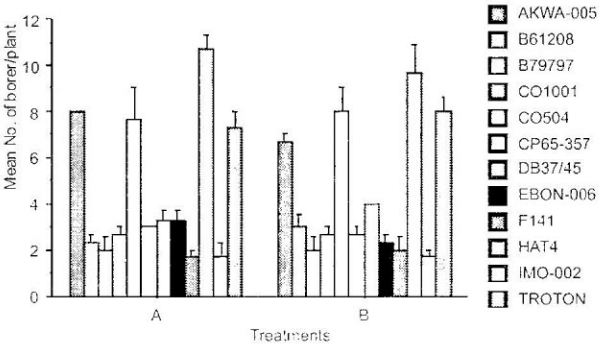

Figure 5: **Effects of sugarcane accessions on number of borer larvae/plant; A=2014, B=2015**

saccharina. Proteinase inhibitors (PIs) of both plant and animal origin have been expressed in sugarcane to impart resistance to borers. In preliminary bioassay studies, a soybean PI incorporated into artificial diet retarded the growth rate and development of *D. saccharalis* (Pompermayer *et al.*, 2001). Based on these results, Falco *et al.*, (2003) developed sugar cane transgenic lines expressing soybean Kunitz trypsin inhibitor (SKTI) and soybean Bowman-Birk inhibitor (SBBI) under the control of the maize ubi-1 promoter. Advantageous use of this technology to produce plants for pest control using different molecules, such as proteinase inhibitors (PI), plant lectins, ribosome inactivating proteins, secondary plant metabolites, delta endotoxins and vegetative insecticidal protein from *Bacillus thuringiensis* (*Bt*) and related species, either alone or in combination with the *Bt* genes (Bates *et al.* 2005), has now been widely recognized for the management of *E. saccharina*. Therefore, engineering insect resistance in the sugar cane plant through expression of such molecules appears to be a realistic approach to mitigate

Table 2: **Effects of sugarcane accessions on number of stool and stalk length (cm)**

Accessions	Stalk length	Number of stool
B61208	130.83^{b}	6.10^{bc}
C01001	150.30^{a}	10.13^{a}
B70707	139.07^{b}	9.47^{a}
F141	114.83^{c}	5.63^{c}
CP65-357	130.97^{b}	10.50^{a}
HAT4	98.58^{c}	5.48^{c}
DB37145	126.70^{b}	6.67^{b}
IMO-002	129.30^{b}	7.37^{b}
EBON-006	130.60^{b}	9.23^{a}
PRITON	122.22^{bc}	7.73^{b}
AKWA-005	115.27^{bc}	7.33^{b}
CO504	117.56^{bc}	7.27^{b}

Means followed by similar letter in a column are not significantly different ($p \geq 0.05$)

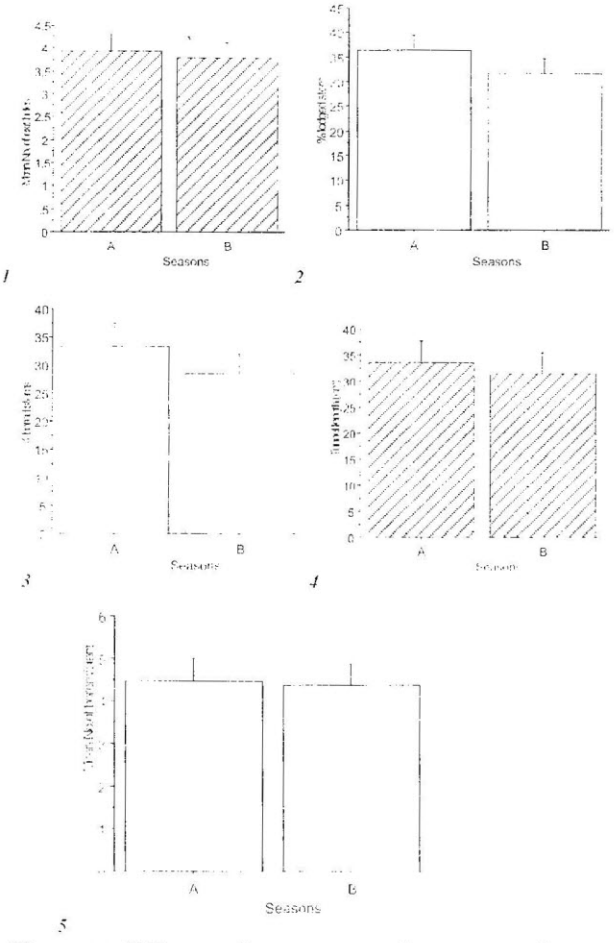

Figure 6: **Effects of seasons on damage and infestation - A=2014, B=2015**

CONCLUSION

Four (AKWA-005, C0504, HAT4 and TRITON) of the 12 sugarcane accessions screened in the field were highly susceptible to *E. saccharina*. Damage to sugarcane by this pest can be mitigated by planting any of the more resistant accession (B61208, C01001, B70607, F141, CP65-357, DB37/45, IMO-002, EBON-006 accessions).

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