Efficacy of Maize Varieties and Lambdacot 500EC Concentrations on the Control of Maize Stem Borer (*Busseola fusca* Fuller) (Lepidoptera: Noctuidae)

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Abstract

The efficacy of maize varieties and Lambdacot 500EC concentrations were assessed on the damage caused by maize stem borer (*Busseola fusca* Fuller) (Lepidoptera: Noctuidae) on maize during 2015 and 2016 cropping seasons. The experiment was a split-plot design with Lambdacot 500EC concentrations (0.5, 1.0 and 1.5 l/ha) as the main plots and three maize varieties (SAMMAZ 14, DMR-LSR-Y and BR9943-DMR-SR-W) as the sub-plots on a plot size of 3.0 m x 4.0 m replicated three times. Maize plants were sprayed with the different Lambdacot 500 EC concentrations at 4 and 6 weeks after planting (WAP). The results obtained showed that lowest number of maize plants with leaf sheath pin-holes, dead hearts, and stem tunnels and cobs damage by larvae were recorded on SAMMAZ 14 and DMR-LSR-Y while BR9943-DMR-SR-W had the highest. Maize plants treated with Lambdacot 500EC at 1.0 l/ha and 1.5 l/ha had lowest leaf sheath pin-holes, dead hearts, stem tunnels and cob damage while untreated maize plants had the highest damage. The highest maize grain yields was recorded on SAMMAZ 14 and DMR-LSR-Y on 1.0 l/ha and 1.5 l/ha concentrations. This study recommended SAMMAZ 14 and DMR-LSR-Y obtained from IAR treated with Lambdacot 500 EC at 1.0 l/ha and 1.5 l/ha concentrations to maize farmers in the study area.

Keywords: Maize, Lambdacot 500EC, Concentrations, Stem borer, *Busseola fusca*.

INTRODUCTION

Maize (*Zea mays* L.) is ranked as the third most cultivated and consumed crop in Nigeria (Uzozie, 2001; FAO, 2010). It is one of the most important cereal crops in Nigeria, Sub-Saharan Africa and in the world (Manyong, *et al.*, 2000; Iken and Amusan, 2004; FAO, 2009). Maize has a wide range of uses, mainly for human food, fodder,

forage and silage. It is Africa's most important staple food crop (FAO, 2009; Ado *et al.*, 2010). It is also very important in the production of starch, alcohol, oil and other products (Kling and Edmeades, 1997; Edgerton, 2009). The stems are used for fencing, fuel, feed, thatching; the produce are used for making mats, baskets, the husks for mats, fuel, potash, erosion control and also as animal feed.

Maize yield averaged 4.9 t/ha globally (Edgerton, 2009). However, yield in major maize

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growing countries of the developing world is still below the global average producing only about 3.10 t/ha (Nunes *et al*, 1985; Downswell *et al*, 1995; De Groote, 2002). The yield potential of maize is greatly affected by insect infestation causing colossal losses. Maize stem borers are the most important field insect pests of maize (Sosan and Daramola, 1999; Ndemah and Schulthess, 2002; Kfir *et al*, 2011). The presence of one or two stem borers in maize plant reduced yield by about 25% (Polaszek, 1998; De Groote, 2002; Malgwi and Adamu, 2013). Damage caused by stem borers could average 20-40% and has been a serious threat to maize production and supply in maize producing African countries (Bosque-Perez and Mareck, 1991; Mailafiya *et al.*, 2011; Mailafiya and Degri, 2012). In Nigeria, maize grain yield losses caused by stem borers ranged between 10-100% (Kolade, 2002). More maize crop damage usually occurs in late season crops and this has made late season maize cultivation unprofitable (IITA, 1987; 2000; Kfir *et al*, 2002).

Yield reduction due to stem borers occurs as a result of leaf feeding, stem tunneling, direct feeding damage to grains (Bosque-Perez and Mareck, 1991, Cardwell *et al.*, 1997). The larvae of the pest tunnel through the nodes and internodes of the plant feeding on its internal tissues which desiccate the terminal growing point thereby resulting in 'dead heart' (Sosan and Daramola, 1999; Mailafiya *et al*, 2011). Depending on the season and nutritional status of plant, crop yield reduction by stem borers feeding and tunneling activities in Africa can be really colossal (Ndemah and Schulthess, 2002; Chabi-Olaye *et al*, 2006). Consequently, farmers are making concerted efforts to control this pest but the problem is still persisting. This could be due to several factors which may include inadequate knowledge of using the correct control measures including the correct and/or recommended insecticides and crop varieties. This study therefore assessed the efficacy of maize varieties and field application of

Lambdacot 500EC concentrations on the control of *B. fusca*.

MATERIALS AND METHODS

Experimental Site

Field experiments were conducted at Leventis Foundation/Gombe State Agricultural Training School, Tumu in Akko Local Government Area of Gombe State, Nigeria during the 2015 and 2016 cropping seasons. The experimental site is located in the Sudan Savanna ecological zone of Nigeria with annual rainfall of between 860-1100 mm; annual temperature of 20°C minimum and 38°C (maximum). The length of the rainy season ranges from 120-150 days usually from May to October (GSADP, 2013).

Sources of Experimental Materials

Three maize varieties (SAMMAZ 14, DMR-LSR-Y and BR9943-DMR-SR-W) were obtained from the Institute for Agricultural Research (IAR) Samaru, Zaria. NPK 15:15:15 fertilizer and Lambdacot 500EC (̳-Cyhalothrin 300g/l + Dimethoate 200 g/l) insecticide were purchased from Agrochemical input Shop in Gombe, Nigeria.

Experimental Design and Field Layout

The three maize varieties (SAMMAZ 14, DMR-LSR-Y and BR9943-DMR-SR-W) and Lambdacot 500EC at four concentrations (0 L/ha, 0.5 L/ha, 1.0 L/ha and 1.5 L/ha) at 4 and 6 weeks after planting (WAP) were laid out in a split-plot design replicated three times. Lambdacot 500EC application was allocated to main plots and the 3 maize varieties were allocated to the sub-plots. The plot size was 3.0 m x 4.0 m with 1.5 m wide border margin between plots and 2.0 m as alley. Each maize stand was planted at 75 x 25 cm (12 m²/0.75 x 0.25 m) giving a maize stand per plot of 64 stands/plot. Maize plant population per plot at 2 plants / stand was (64 x 2) 128 plants. Total maize plants (population) on the experimental field was 600,000

per hectare (100,000/12 x 72 plots). The actual field size was 12 x 72m = 864m².

Land Preparation

The land was cleared of debris, leveled manually by using hand held hoes in order to pulverize and level the land to fine tilt when the rainfall has become steady in June. The field was then mapped out and ridged at 75 cm apart to provide suitable drainage channels and seed beds for seed germination, growth and establishment (GSADP, 2013).

The maize seeds were planted on 6th July, 2015 and 29th June, 2016 when rainfall became steady. The maize seeds were sown manually at 3 seeds per hole at a planting depth of 2.5 cm. Seedlings were thinned to two plants per stand at 3 WAP. Weeding was done manually using hand held hoe as required. A compound fertilizer (N.P.K. 15:15:15) was applied in two split doses using spot application at 3 and 6 WAP (GSADP, 2013).

Data Collection

The following data were collected and analyzed.

- a. **Number of maize plants with leaf sheath pin-holes:** It was obtained by taking five maize plants at random from each plot and counting the leaf sheath with holes.
- b. **Number of maize plants with “dead hearts”:** five maize plants were selected at random from each plot and counting those with dead hearts (dead growing points).
- c. **Number of maize plants with stem holes/tunnels:** Stem holes/tunnels were counted per plant on randomly selected five maize plants per plot.
- d. **Number of maize cobs with stem borer larvae feeding damage:** For recording maize cobs damaged by stem borer feeding, five cobs were selected at random from each

plot and maize cobs with larvae feeding damage were recorded and averaged.

- e. **Grain yield:** For obtaining maize grain yield, cobs of all the plants from each net plot were sun dried and shelled with a mechanical sheller to obtain the grain yield. The produce was weighed using a spring balance (Genway Model 1300TL) in kg/ha.

Collection of Adults

Maize stem borers were collected from the leaf sheaths, dissected stems and cobs and reared in the laboratory to obtain the adults. The adults were identified using identification guide and charts (Amatobi, 2007; Omoloye, 2008).

Pictures of damages caused by maize stem borer were taken in the field. The larvae were reared by cutting the fresh maize stem in the field, chopping them into the sizes that will enter the rearing jar in the laboratory. The chopped stems were then washed with clean water to avoid introducing the maize stem-borer parasitoids and parasites in the rearing jar. The washed stems were then fed to the maize stem borer larvae.

Data Analysis

Data collected were subjected to analysis of variance (ANOVA) (SAS, 2003) and where there were significant differences, the treatment means were separated at 5% level of probability using Student Newman-Kuels test (SNK).

RESULTS

Number of maize plants with leaf sheath pin-holes

Table 1 shows that SAMMAZ 14 had the lowest (1.40) while BR9943-DMR-SR-W had significantly higher ($p < 0.05$) number of sheath leaf with pin-holes than other varieties. Lambdacot 500EC applied at 1.0 and 1.5 L/ha gave significantly lower mean (1.52) number of leaf sheaths with pin-holes than the control.

Number of maize plants with “dead hearts”

The results showed that there was significant difference ($p < 0.05$) among the varieties and insecticides concentrations applied (Table 1). SAMMAZ 14 and DMR-LSR-Y had significantly lower ($p < 0.05$) number of maize plants with dead hearts. BR9943-DMR-SR-W had highest number of maize plants with dead heart. Maize plants treated with Lambdacot 500EC at 1.5 L/ha concentration had reduced number of maize plants with dead hearts (1.23) while untreated maize plants that did not receive treatment (0.0 L/ha) showed highest number of maize plants with dead hearts (2.33).

Number of maize plants with stem holes/tunnels

Table 1 shows that SAMMAZ 14 and DMR-LSR-Y had significantly lower stem tunnels at harvest (1.43 and 1.47 respectively) than BR9943-DMR-SR-W. The insecticide-treated maize plants at 1.5 L/ha reduced the stem borer with only 1.03 tunneled, while untreated (0.0L/ha) maize plants had the highest (3.76) maize plants with tunnels.

Number of maize cobs with stem borer larvae feeding damage at harvest

Results on the effects of maize varieties and Lambdacot 500EC concentrations showed that BR9943-DMR-SR-W maize variety had significantly higher (4.33) number of maize cobs with larvae feeding damage (4.33) than either SAMMAZ 14 or DMR-LSR-Y varieties (Table 2). Furthermore, the results showed that 1.0 and 1.5 L/ha application rates were found to be effective in reducing the maize cob larvae feeding effect than the control.

Grain yield

DMR-LSR-Y gave more dry grain yield (5483.12 kg/ha) followed by SAMMAZ 14 (5421.33 kg/ha) while BR9943-DMR-SR-W gave the lowest grain yield (4605.61 kg/ha) (Table 2). Plots treated with Lambdacot 500 EC at 1.5L/ha produced the highest maize grain yield (5670.27 kg/ha) followed by 1.0 L/ha (5078.64 kg/ha) while untreated control (0.0L/ha) produced the lowest maize grain yield (2995.72 kg/ha). The interaction analysis of the data collected showed that there were no significant differences between the varieties and the insecticide concentrations.

Table 1: Number of maize plants with feeding symptoms caused by stem borer

Treatment	No. of plants with leaf sheath pin-holes		No. of plants with “dead hearts”		No. of plants with stem tunnels	
Variety (V)	2015	2016	2015	2016	2015	2016
SAMMAZ 14	1.39 ^b	1.40 ^{ab}	1.32 ^a	1.30 ^a	1.41 ^a	1.43 ^a
BR9943-DMR-SR-W	2.22 ^a	2.20 ^{ba}	1.70 ^b	1.68 ^b	1.83 ^{ab}	1.84 ^b
DMR-LSR-Y	1.52 ^b	1.52 ^{ab}	1.55 ^a	1.56 ^a	1.47 ^a	1.46 ^a
SE ±	0.37	0.38	0.18	0.19	0.26	0.27
Insecticide Concentrations (C)						
0.0L/ha	3.12 ^b	3.13 ^b	2.34 ^b	2.33 ^b	3.76 ^b	3.76 ^b
0.5 L/ha	2.43 ^{ab}	2.42 ^{ab}	1.98 ^{ab}	1.99 ^{ab}	2.14 ^{ab}	2.12 ^{ab}
1.0 L/ha	1.44 ^a	1.42 ^a	0.66 ^a	0.65 ^a	1.26 ^a	1.26 ^a
1.5 L/ha	1.15 ^a	1.13 ^a	0.22 ^a	0.23 ^a	1.04 ^a	1.02 ^a
SE±	0.94	0.96	1.34	1.36	0.96	0.97
Interactions V x C	NS	NS	NS	NS	NS	NS

Mean values with the same letter(s) in the same column are not significantly different ($p > 0.05$) using Student Newman Keuls; NS = Not significant.

DISCUSSION

Among the maize varieties, it was found that SAMMAZ 14 had significantly lower number of maize plants with leaf sheath pin-holes, dead hearts, stem tunnels and maize cobs with larvae feeding damage while BR9943-DMR-SR-W had significantly higher maize plants with leaf sheath

pin-holes, dead hearts stem tunnels and maize cobs with larvae feeding damage. This result indicates that SAMMAZ 14 variety is more resistant to maize stem borers than DMR-LSR-Y and BR9943-DMR-SR-W varieties (Holloway, 1998; Manyong, *et al.*, (2000); Iken and Amusan, 2004). This is in agreement with the findings of Ndemah

Table 2: Number of maize cobs with stem borer damage and grain yield

Treatment	No. of maize cobs with larvae feeding damage		Grain yield (kg/ha)	
Variety (V)	2015	2016	2015	2016
SAMMAZ 14	2.22 ^a	2.21 ^a	5421.33 ^a	5419.68 ^a
BR9943-DMR-SR-W	4.34 ^b	4.33 ^b	4605.61 ^b	4607.11 ^b
DMR-LSR-Y	2.25 ^a	2.24 ^a	5483.12 ^a	5485.10 ^a
SE ±	1.68	1.67	815.71	816.67
Insecticide Concentrations (C)				
0.0L/ha	4.23 ^a	4.23 ^a	2995.72 ^b	2996.12 ^b
0.5 L/ha	2.58 ^{ab}	2.57 ^{ab}	3764.51 ^b	3763.12 ^b
1.0 L/ha	1.54 ^b	1.53 ^b	5078.64 ^{ab}	50.65 ^{ab}
1.5 L/ha	1.15 ^b	1.13 ^b	5670.27 ^a	5671.33 ^a
SE±	3.49	3.48	2239.62	2239.13
Interactions				
V x C				

Mean values with the same letter(s) in the same column are not significantly different ($p>0.05$) using Student Newman Keuls; NS = Not significant.

and Schulthess (2002) who reported that maize stem borer can cause serious damage to maize varieties that are not resistant and caused colossal loss of up to 40% damage. Mailafiya and Degri (2012) also reported that stem borer infestation is a constraint and a threat to maize production in maize producing countries. Bosque-Perez and Schulthess (1998) reported that maize stem borer (*Busseola fusca*) implicit serious damage to maize plants and grains in the field. It also predisposes the plant to diseases through the bored holes created and subsequently causing maize stem lodging and breakage (Bosque-Perez and Mareck, 1991; Sosan and Daramola, 1999; Ado *et al.*, 2010).

Among the Lambdacot 500EC concentrations used during the study, 1.5 L/ha concentration rate was found to be more effective in reducing the number of pin-holes, dead hearts, stem tunnels and maize cobs damage than 0.5L/ha and 1.0 L/ha. Untreated maize plots (0.0L/ha) had higher number of pin-holes, dead hearts, stem tunnels and maize cobs damage. This implies that Lambdacot 500EC applied at 1.5 L/ha was the appropriate concentration for the control of maize stem borer (*B. fusca*) for SAMMAZ 14 and DMR-LSR-Y varieties in the study area. Maize plots treated with Lambdacot 500EC at 0.5L/ha and 1.0L/ha were less effective in the control of maize stem borers during the study. This implies that this insecticide

sprayed at these concentrations were not the appropriate rate for the control of maize stem borer. Bosque-Perez and Mareck (1991) and Cardwell *et al.* (1997) reported that the application of insecticides at the recommended rates will give the needed control of maize stem borers while application of wrong concentrations will not be effective against the pest and may even cause pest resistance and resurgence. The performance of the three maize varieties showed a significant difference in maize grain yield. SAMMAZ 14 and DMR-LSR-Y produced more maize grains than BR9943-DMR-SR-W variety. This implies that these two varieties are resistant to maize stem borer compared to BR9943-DMR-SR-W. Stem borers have been a serious threat to maize grain production in Nigeria. The cultivation of resistant maize varieties will minimize the incidence, abundance and infestation of maize by the stem borer (Mailafiya and Degri, 2012).

Among the four concentrations of Lambdacot 500EC, it was found that maize plots treated at 1.5 L/ha had the highest maize grain yield while untreated maize plots had the lowest maize grain yield. This indicated that Lambdacot 500EC sprayed at 1.5L/ha was the appropriate concentration of the insecticide used during the study (Bosque-Perez and Mareck , 1991, Cardwell *et al.*, 1998). This implies that Lambdacot 500EC applied at 1.5 L/ha is the appropriate concentration for optimum maize grain production in the study area. However, the lowest maize grain yield recorded at 0.5 L/ha and 1.0 L/ha concentrations means that they are not quite adequate for maize stem borer control and not appropriate for optimum maize grain production. The interaction analysis of the data collected showed that there were no significant difference between the varieties and the insecticide concentrations.

CONCLUSION

This present study showed that maize stem borer (*Busseola fusca*) is a major insect pest of maize. It is a major constraint to maize production in the study area. The use of different maize varieties treated with Lambdacot 500EC at 1.5 L/ha concentration was effective in the control of stem borer. SAMMAZ 14 and DMR-LSR-Y were confirmed to be resistant to maize stem borer compared to BR9943-DMR-SR-W variety. Lambdacot 500EC application at 1.5 L/ha was effective in the control of pin-holes, dead hearts, stem tunnels and maize cobs damage while improving maize grain yield in the study area. Furthermore, interactions between the maize varieties and Lambdacot 500EC concentrations on the performance of maize showed that there was no significant difference.

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