EFFECTS OF *Capsicum frutescens* AND *Azadirachta indica* AGAINST STEM BORER INFESTATION ON SORGHUM IN NORTH EASTERN NIGERIA

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Abstract: Synthetic insecticides which are now known to produce negative environmental, health and economic impact, have been heavily relied on in the control of stem borers on sorghum. This experiment therefore examines chili pepper (*Capsicum frutescens)* and neem (*Azadirachta indica*) formulations in checking damages associated with stem borers on sorghum. Field trials were laid in Potiskum (Lat. 11°43'N and Long. 11°04'E) in 2011 and 2012 wet seasons. Treatments evaluated were Chili Pepper Powder, Chili Pepper Powder + Fine sand (1:1, w/w), Neem Kernel Powder, Neem Kernel Powder + Fine sand (1:1, w/w), Carbaryl Dust (Synthetic insecticide) and untreated control using a Randomized Complete Block Design with three replicates. Data on Dead hearts (%), Stem tunneling length (%), Incidence of Chaffy Panicles (%), Stem breakage (%) and, Grain Yield (Kg/plot) were collected. Statistical analysis showed significant differences ($p \leq 0.05$) between treated and untreated plots across the parameters. Mean separation however, shows no significant difference ($p \geq 0.05$) between the botanicals and the synthetic insecticide. Cumulatively, Neem Kernel Powder + Fine sand gave the best control with the lowest dead hearts (0.65%, 0.71% [35 days after sowing], 0.80% and 0.80% [45 days after sowing]), Stem tunneling length (12.09% and 12.18%), chaffy panicles (2.26% and 2.11%), Stem breakage (3.01% and 2.60%) and the highest grain yield (6.39 and 6.35 kg/plot) in 2011 and 2012, respectively. The overall result suggests that Neem Kernel Powder + Fine sand may serve as an alternative to synthetic insecticides and a viable component of the Integrated Pest Management of Sorghum Stem borers.

Keywords: *Azadirachta indica*, *Capsicum frutescens*, chaffy panicles, dead heart.

Introduction

Sorghum, commonly called Guinea corn [*Sorghum bicolor* (L) Moench] ranks 5th in cereals global production and is the most widely cultivated cereal crop in the North Eastern Nigeria (Ajayi, 1998; Korlapati and Singh, 2014). It is used for food, beverages, biofuels, thatching of roofs and fencing of compounds (MAFAP, 2013). Insect pests constitute an important factor limiting grain sorghum production in West Africa as a whole. The most important field insect pests are shoot flies, stem borers, head bugs, head caterpillars, and grain midges. Of these, the stem borers are the most important (Ajayi, 1987; Okrikata and Anaso, 2008; Malgwi and Adamu, 2013).

In West Africa, lepidopterous stem borer species such as *Busseola fusca* (Fuller), *Sesamia calamistis* (Hampson), *Sesamia poephaga* (Tatns and Bowden), *Sesamia penniseti* (Tarns and Bowden), *Coniesta ignefusalis* and *Eldana saccharina* have been found infesting sorghum (Ajayi, 1987). In Nigeria, a number of stem borer species have also been reported as serious pests of sorghum with *Busseola fusca* being the most important in the North Eastern region (Okrikata and Anaso, 2008; Malgwi and Adamu, 2013).

Stem borer damage is caused by the larvae which at first feeds on the young leaves and then, tunnel into the stems during the early stages of crop growth. The larvae may kill the growing points, resulting in the production of 'dead heart' and consequent loss of crop stands. At later stages of growth, extensive tunneling leading to breakage of stalks and peduncles occur which have negative impact on grain development (Harris and Nwaze, 1992; Mathieu *et al*., 2006; Van den Berg, 2009). The effect of stem borer infestation on yield is variable (ranging from negligible to total crop loss) depending upon location, borer species composition, abundance, varietal susceptibility, season, sowing date and, plant-pest interaction, which is regulated by the climatic, edaphic and the biotic environment (Ajala *et al*., 2010; Okweche *et al*., 2013). Grain yield losses ranging from 10% to 80% have been reported as a result of stem borer infestations (Kfir *et al*., 2002; Malgwi, 2006).

Controlling stem borers is difficult and this is largely due the nocturnal habits of the adult moths and the cryptic feeding behavior of the larvae which reside and feed inside the plant stems. Synthetic insecticides such as Carbaryl 85WP, granular Endosulfan 5G and, granular Trichlorphon 5G applied into the whorl three (3) times at weekly intervals have been recommended for stem borer management (Ajayi, 1987). However, some of these insecticides have now been banned due to the negative environmental and health impact occasioned by their high persistence.

Aside high cost of synthetic pesticides which limits access by resource limited farmers, intensive agricultural practices relying heavily on synthetics pesticides are a major cause of widespread ecological imbalances resulting in serious problems of pesticide resistance, pest resurgence and, pesticide residues leading to enormous health challenges. In view of these, the development, dissemination and promotion of sustainable biointensive approaches are currently being advocated for.

Plant based insecticides (Botanicals) have been found to be environmentally friendly and research findings have revealed that neem (*Azadirachta indica*) and chili pepper (*Capsicum frutescens*) have repellent, antifeedant, oviposition deterrent, development inhibiting, reduced insect resistance and broad spectrum properties vis-à-vis insect pests (Asawalam *et al.*, 2007). Hence, this study is focused on comparatively assessing the efficacy of chili pepper and neem based powdered formulations for the control of sorghum stem borer species.

Materials and Methods

Experimental design and treatments evaluated

A two (2) year field trial was conducted in Potiskum (Lat. 11°43'N and Long. 11°.04'E), Yobe State of Nigeria during the wet seasons of 2011 and 2012. The experimental design was Randomised Complete Block Design (RCBD) in which the land was demarcated into three (3) blocks (replicates) and each block had six (6) plots with a size of 5 m x 5 m (25 m^2). A recommended high-yielding sorghum cultivar (KSV4) obtained from Borno State Agricultural Development Programme (BOSADP) was sown at 75 cm x 40 cm intra and inter-row spacing, respectively.

Before sowing, the seeds were dressed with metalaxyl (Apron Star 42 WS) to control pre and post - emergence damping - off of seedlings and to prevent birds and ants from picking the seeds or destroying the seedlings. The treatments evaluated were; Chili Pepper Powder (CPP), CPP + Fine sand (1:1, w/w), Neem Kernel Powder (NKP), NKP + Fine sand (1:1, w/w), Carbaryl Dust (Synthetic insecticide) and, Untreated Control.

Preparation and application of treatments

Neem kernels were collected within Potiskum town, air dried and pounded with a wooden mortar and pestle. The pounded kernels were further pulverised with the Molinex brand blender (MX-795N) to obtain fine neem kernel powder (NKP). Chili pepper fruits purchased from Potiskum market were air dried and ground into powder using the electric powered blender while, fine sand was collected from a river bank.

The diluents; neem kernel powder, chili pepper powder and, fine sand were sieved separately with a Suplex Standard Test Sieves (Grade 250 µm) to smoothen them by removing larger particles. A 1:1 weight basis mixture of NKP + Fine sand and CPP + Fine sand was prepared in a wide container. The individual mixtures were further ground in the electric blender to ensure homogeneity of the mixture. For the purpose of comparison, Carbaryl Dust was used as treated (positive) control.

Application of treatments commenced twenty (20) days after sowing (DAS). The treatments were applied by introducing approximately 5 g of each insecticide formulation into the whorl of the plants. This was repeated at ten (10) days intervals; four (4) such applications were made until 50% booting stage.

Data collection and analysis

At 35 and 45 DAS, ten (10) pre-tagged plants/plot were used in assessing the proportion of plants killed by stem borers. This was done by counting the number of dead hearts. Stem breakage and incidence of chaffy panicles were also assessed from ten (10) pre-tagged plants before harvest. At harvest, ten (10) randomly selected plants were split open to measure tunnel length in relation to the total length of the stem.

Data in percentages (%) were transformed to arcsine before subjecting them to Analysis of Variance (ANOVA) and Means separated by Least Significance Difference (LSD) using the analytical software, statistix version 8.0 (SXW) at 5% level of probability. However, to document the stem borers species composition and relative abundance; immature stages were collected from infested plants in the untreated plots after splitting the stems open; reared to adults and identified in the laboratory. The population of the individual stem borer species were pooled and expressed in percentages.

Results and Discussion

Busseola fusca was the most predominant stem borer species retrieved from the stems of the crop accounting for 43.4% of the total stem borer species collected. This was followed by *Sesamia calamistis* (23.0%), *Coniesta ignefusalis* (20.4%), *Chilo partellus* (8.8%) and, the least abundant being; *Eldana saccharina* (4.4%) (Fig. 1). This is in line with the findings of Bamaiyi and Joan (2011), Okweche *et al.* (2013) and, Ekoja *et al.* (2015) who reported that most stem borer attacks on cereal crops results from infestation by more than one species.

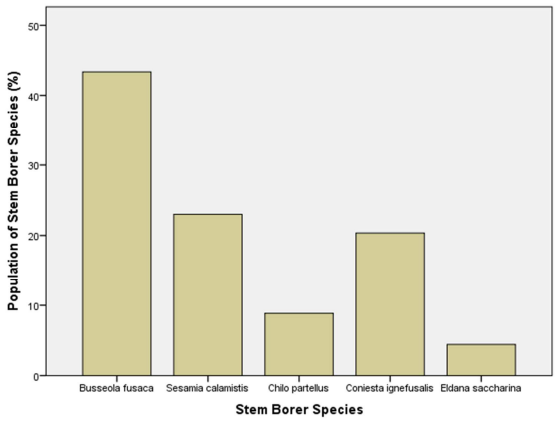

Figure 1: Species composition and relative abundance (%) of stem borers on sorghum in North-eastern Nigeria

Even though complete prevention of infestation by borers was not achieved, significantly reduced damage and better yield was obtained as a result of insecticide application. The research results shows that, at 35 and 45 DAS, all the insecticidal treatments were significantly ($p \leq 0.05$) effective in checking dead hearts (destruction of the growing points in the whorl due to stem borer's feeding activities) when compared with the untreated control in both 2011 and 2012. While mean separation shows no significant difference ($p \geq 0.05$) between the botanicals and the synthetic, it was generally observed that, the botanicals performed better than the synthetic, Carbaryl Dust (Table 1). In checking stem tunneling length, stem breakage and incidence of chaffy panicles due to stem borers, all the insecticidal treatments were also significantly ($p \leq 0.05$) effective over the untreated control (Table 2). As observed in Table 1, the mean separation in Table 2 shows no significant difference ($p \geq 0.05$) between the botanicals and the synthetic (Carbaryl Dust).

Table 1. Effect of whorl application of chili pepper and neem powder formulations and carbaryl dust on incidence of dead hearts caused by stem borer species on sorghum

Treatment	Dead hearts at 35 DAS (%)		Dead hearts at 45 DAS (%)	
	2011	2012	2011	2012
CPP	0.07 (0.94)	0.03 (0.65)	0.10 (1.30)	0.09 (1.07)
CPP + Fine sand	0.05 (0.81)	0.04 (0.71)	0.07 (0.94)	0.06 (0.88)
NKP	0.06 (0.88)	0.05 (0.81)	0.10 (1.30)	0.09 (1.08)
NKP + Fine sand	0.03 (0.65)	0.04 (0.71)	0.05 (0.80)	0.05 (0.80)
Carbaryl Dust	0.08 (1.04)	0.08 (1.05)	0.11 (1.34)	0.12 (1.37)
Untreated Control	1.84 (7.78)	1.82 (7.67)	9.17 (17.01)	9.10 (16.87)
Mean	2.01	1.93	3.78	3.68
SE(±)	0.52	0.50	0.65	0.66
LSD	1.05*	1.18*	1.49*	1.41*

Means in parenthesis are arc-sine transformed values; * - Significant at p≤0.05; NKP - Neem Kernel Powder; CPP - Chili Pepper Powder; DAS – Days After Sowing

Table 2. Effect of whorl application of chili pepper and neem powder formulations and carbaryl dust on stem tunneling length, stem breakage and incidence of chaffy panicles caused by stem borer species on sorghum

Treatment	Stem Tunneling Length (%)		Stem Breakage (%)		Incidence of Chaffy Panicles (%)	
	2011	2012	2011	2012	2011	2012
CPP	6.12 (12.91)	6.13 (13.04)	0.41 (3.01)	0.25 (2.11)	0.07 (0.94)	0.06 (0.88)
CPP+Fine sand	6.11 (12.74)	6.11 (12.74)	0.33 (2.60)	0.30 (2.35)	0.24 (2.11)	0.24 (2.11)
NKP	6.17 (13.11)	6.12 (12.91)	0.33 (2.59)	0.22 (2.07)	0.12 (1.38)	0.12 (1.38)
NKP+Fine sand	6.03 (12.09)	6.05 (12.18)	0.22 (2.02)	0.33 (2.60)	0.27 (2.26)	0.25 (2.11)
Carbaryl Dust	6.13 (13.04)	6.13 (13.04)	0.22 (2.07)	0.22 (2.07)	0.30 (2.35)	0.33 (2.61)
Untreated control	27.13 (31.01)	27.10 (30.97)	1.84 (7.80)	1.79 (7.59)	2.03 (8.15)	2.03 (8.15)
Mean	15.85	15.81	3.35	3.13	2.87	2.87
SE(±)	0.77	0.79	0.61	0.58	0.59	0.60
LSD	2.05*	2.09*	1.38*	1.31*	1.25*	1.29*

Means in parenthesis are arc-sine transformed values; * - Significant at p≤0.05; NKP - Neem Kernel Powder; CPP - Chili Pepper Powder

Table 3 also, shows that the various insecticidal treatments administered significantly (p≤0.05) influenced higher yield over the untreated. Again, while there was no significant difference (p≥0.05) between the botanicals and the synthetic; the botanicals influenced higher yield over the synthetic. The mean grain yield of 2011 and 2012 showed that NKP + Fine sand gave the highest grain yield increase of 22% and Carbaryl Dust (synthetic insecticide) gave the least grain yield increase (19.7%) over the untreated control (Table 3).

Table 3: Effect of whorl application of chili pepper and neem powder formulations and carbaryl dust on sorghum grain yield

Treatment	Grain Yield (Kg/Plot)			Yield Related Indices
	2011	2012	Mean (Kg/Plot)	GYI (%)
CPP	6.32	6.33	6.33	21.5
CPP + Fine sand	6.33	6.34	6.34	21.6
NKP	6.34	6.33	6.34	21.6
NKP + Fine sand	6.39	6.35	6.37	22.0
Carbaryl Dust	6.19	6.18	6.19	19.7
Untreated Control	4.95	4.98	4.97	
Mean	6.09	6.09		
SE(±)	0.69	0.68		
LSD	1.42*	1.44*		

* - Significant at p≤0.05; NKP - Neem Kernel Powder; CPP - Chili Pepper Powder; GYI – Grain Yield Increase over Untreated Control

The overall result agrees with the observations of Okrikata and Anaso (2008) and Ogah *et al.* (2011) who reported a significant (p<0.05) reduction on stem borer damage and an increase in grain yield of cereal crops treated with neem based botanicals when compared with untreated control. Aside having insecticidal, repellent, insect growth regulatory, sterility induction, and oviposition inhibiting properties (Satti *et al*., 2013), neem based insecticides have been discovered to have systemic action (Mordue and Blackwell, 1993). Chili pepper based insecticides on the other hand have also been reported to produce insecticidal, stomach poison, repellent, antifeedant and fumigant effect on a wide array of insect pests (Adedire and Ajayi, 1996; Asawalam *et al.*, 2007).

While there was no significant difference (p≤0.05) between the botanicals used and Carbaryl Dust (synthetic insecticide); it was observed that overall, NKP + Fine sand was quite outstanding in checking stem borer damage which resulted in the highest grain yield of 6.37 kg/plot based on the mean grain yield of 2011 and 2012.

The efficacy of the botanicals used over the synthetic agrees with the findings of Rensburg and Hamburg (1975), Seshu Reddy (1988), Mailu (1997), Asawalam *et al.* (2007) and, Okrikata and Anaso (2008) who all reported that botanicals gave similar and sometimes even better level of control than synthetic insecticides. The comparatively better performance observed on sorghum plants treated with fine sand formulated botanicals, may be attributed to the abrasive property of fine sand which abrade the cuticles of the stem borers and/or impede their gnawing activity as reported by David and Gardiner (1950), Hassall (1990) and, Lale (2002).

Conclusion

The study was carried out to evaluate chili pepper and neem powder formulations for the control of sorghum stem borers. A complex of stem borer species were found attacking the crop and the result showed significant increase in grain yield when the borers were controlled. It was observed that, while the plant-based insecticidal formulations were significantly effective in checking stem borers damage symptoms; there was generally no significant difference between the botanicals and carbaryl. Therefore, the plant-based (chili pepper and neem seed kernel) insecticidal powdered formulations used in this research could be viable tools in the Integrated Pest Management of sorghum stem borers and will also go a long way to assist the resource limited farmers who are

finding it difficult access synthetic pesticides due to their high cost.

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