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Economic Viability of Chilli Pepper and Neem Seed Kernel Powdered Formulations Vis-à-vis Sevin Dust (85%) in the Management of Lepidopterous Stemborers on Sorghum in North Eastern Nigeria

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Abstract
A two year field experiment was designed to evaluate the economic viability of Chilli Pepper and Neem Kernel based powdered formulations vis-à-vis Sevin Dust (85%) in controlling stemborer damage on Sorghum variety (KSV4) in 2009 and 2010 using a Randomized Complete Block Design (RCBD). The botanicals evaluated are Chilli Pepper Powder (CPP), CPP + Finesand (1:1, w/w), Neem Kernel Powder (NKP) and, NKP + Finesand (1:1, w/w). The results shows that pesticides used significantly ($p<0.05$) reduced stemboring by stemborers. The results also shows that the botanicals significantly ($p<0.05$) perform better than the synthetic in reducing stemboring. While the grain yield were significantly ($p<0.05$) higher on the treated plots over the untreated, the results further reveals that there was no significant difference between the botanicals and the synthetic used even though NKP + Finesand gave the overall best yield. The economic analysis also shows that it was profitable and economically viable to use any of the pesticides in controlling stemborers on sorghum since all the pesticides gave a ratio of more than one. However, NKP + Finesand gave the highest cost: benefit ratio of 1:5.76 and 1:5.48 in 2009 and 2010, respectively followed by CPP and Finesand, NKP, CPP while Sevin 85% gave the least cost: benefit ratio of 1:2.48 and 1:2.40 in 2009 and 2010, respectively. While the cost: benefit analysis was strictly based on the cost of plant protection only and did not consider factors such as potential impact on natural enemies/non-targets, the environment, farm workers and consumer safety, the overall results shows that Neem Kernel and Chilli Pepper based botanicals can be useful components of Integrated Pest Management (IPM) of Sorghum Stemborers and may serve as viable alternatives to the synthetics which have been identified to have several environmental and health implications.
Keywords: Cost: Benefit Ratio, *Sesamia calamistis*, Botanicals, Stem Bored, Number of Holes Per Stem Finesand, *Capsicum frutescens* (Chilli pepper), *Azadirachta indica* (Neem), Sevin Dust (85%)

INTRODUCTION

Sorghum (*Sorghum bicolor* [L.] Moench) is one of the most important staple foods for millions of poor rural people in the semi-arid tropics of Asia and Africa. It grows in harsh environments where other crops do not grow well. Reports on grain yield losses in sorghum due to lepidopterous stemborer species can lead to total crop loss (Ajayi, 1998, Okrikata and Anaso 2008, MAFAP, 2013). Farmers rely predominantly on synthetic insecticides for their control. However, high cost and, rising awareness of their ecological and health hazards have generated interests on plant based pesticides which are generally viewed as safer.

Research findings have shown that plant based pesticidal formulations were effective against agricultural insect pests (Kairie and Saxena, 1993, Hellpa, 2002 and Okrikata and Anaso, 2008). In Nigeria, Botanical pesticides have been extracted from various plants including Tobacco (*Nicotinia tabacum),* Derris *(Derris elliptica),* Pawpaw *(Carica papaya),* neem (*Azadirachta indica*), Siam weed (*Chromolaena odoratap*), Bitter leaf (*Vernonia amygdalina*), Basil (*Ocimum basilicum*), Garlic (*Allium sativum*), Alligator pepper (*Aframomum melegueta*) and a host of others. Their biological properties have been tested and found to include insecticidal and repellent effects against insect pests. Some have also been found to have antifeedant, growth regulatory, oviposition inhibitory, sterility inducing, antifungal and nematicidal properties (Okrikata and Anaso, 2008). However, the use of botanicals must be economically viable if their potential is to be realized. The low level usage of botanical insecticides globally have been reported to be attributed to cost, availability and inconsistency in their efficacy. Again, farmers usually prefers a very rapid knock-down pesticide as against the slow activity associated with botanicals (Ngbede *et al.*, 2014).

The cost: benefit ratio is an indicator of the relative economic performance/viability of the treatment. To be economically viable, a pest management strategy must at least cost less than the value of the increase in crop yield that the control produces. Thus elaborate use of pesticides on staple food crops is not generally practiced because even though yields may be substantially increased, the value of the extra produce may not

offset the costs involved. There is, therefore, a high level of uncertainty about the economics of any specific control strategy, hence the need to carry out an economic viability (Cost-benefit ratio) analysis of the pest management strategies employed.

However, while a sizable number of researches has been carried out to access the bioefficacy of botanicals, very little has been done on their cost-benefit potential vis-à-vis conventional synthetic pesticides. This paper therefore, addressed the economic viability of using Chilli Pepper and Neem Seed Kernel Powdered formulations vis-à-vis Sevin Dust (85%) – a synthetic insecticide in managing lepidopterous stemborer species on sorghum.

A ratio of one (1) indicates that the venture is neither making profit or loss – it is breaking even. A ratio of less than one (< 1) means a loss, while a ratio of more than one (> 1) indicates a profit (Ngbede *et al.,* 2014).

MATERIALS AND METHODS

Experimental Design and Treatments Evaluated

A two 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 2009 and 2010. The predominant stemborer species within the study location is *Sesamia calamistis.* 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 5m x 5m ($25m^2$). A recommended high-yielding sorghum cultivar (KSV4) 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;

1. Chili Pepper Powder (CPP)
2. CPP + Finesand (1:1, w/w)
3. Neem Kernel Powder (NKP)
4. NKP + Finesand (1:1, w/w)
5. Sevin Dust (85%) (Synthetic insecticide)
6. Untreated Control

Preparation of Treatments

Air dried neem kernels were pounded with wooden mortar and pestle and then pulverised with the Molinex brand blender (MX-795N) to obtain the pure neem kernel powder (NKP). Again, to obtain the pure chili pepper powder; Chili Pepper fruit was obtained, air dried and ground into powder using the electric powered blender. Finesand was collected from the river bank. Each of the diluents; the pure neem kernel powder, the pure chili pepper powder and, finesand were seived with the Suplex Standard Test Sieves (Grade 250µm) to smoothen the powder by removing larger particles.

A thorough mixture (1:1 weight basis) of NKP + Finesand and CPP + Finesand was done 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, Sevin Dust (85%) was used as treated control. Meanwhile, in order to ensure good stemborer population build-up, the crops were sown a few weeks after rain establishment.

At two (2) weeks after sowing (DAS), the treatments were applied by introducing approximately 5g of each pesticide 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

Data Average stem bored (%) and Average number of holes per stem was collected and the data subjected to analysis of variance (ANOVA) and means separated by least significant difference at 5% level of probability.

ECONOMIC ANALYSIS

Cost of Application of Insecticides

The cost of purchase of sevin dust (85%) and chili pepper fruit was documented. The labour cost for collection of neem seed kernel from the immediate community was also taken. Labour cost for preparation and application of insecticides was also recorded. The labour cost was based on the unskilled labourer daily wage of #700 in 2010 in the study area.

In calculating the cost of application of insecticides, the cost per application was worked out based on the treatment dose per hectare, per application and multiplying by the number of applications.

Gross Income

The gross income was calculated by multiplying the yield (kg/ha) with the average cost of sorghum grain in the local market.

Cost-Benefit Analysis

The cost: benefit ratio was worked out by subtracting the income of the untreated control plots from the income of the treated plots and dividing the products by the total cost of application of each insecticidal treatment (Shabozoi *et al.,* 2011). The assessment of the economic viability (cost: benefit ratio) of the treatments is therefore based on the cost of plant protection only which is similar to that done by Patel *et al.,* 1997; Shabozoi *et al.,* 2011, Ngbede *et al.,* 2014 and Amoabeng *et al.,* 2014. Factors such as potential impact on natural enemies/non-targets, the environment, farm workers and consumer safety associated with each of the treatments was not considered in the analysis.

RESULTS AND DISCUSSION

Table 1 and 2 shows the relative performance of Chilli pepper and neem based powdered botanicals vis-à-vis Sevin Dust (85%) in checking stemboring by lepidopterous stemborers on sorghum and their cost benefits in 2009 and 2010. Both tables shows that the pesticides applied significantly ($p<0.05$) reduced the average stems bored and number of holes per stem of the sorghum plant. Again, while there were no significant ($p<0.05$) difference between the botanicals used in this research (eventhough, NKP + Finesand performed better than the other botanicals) in both years, the results shows that the botanicals were significantly ($p<0.05$) more effective than the synthetic (Sevin Dust - 85%) in checking stemboring. On the other hand, the results shows that, while all the pesticides treated plots gave a significantly ($p<0.05$) higher grain yield than the untreated plots, there was no significant ($p<0.05$) difference between the botanicals and the synthetic pesticides used in this research interms of grain yield.

The relative effectiveness of the botanicals used over the synthetic (Sevin Dust, 85%) in checking stemboring by the stemborers agrees with the observations of Seshu Reddy, 1988, Mailu, 1997, Rensburg and Hamburg, 1975; Danka, 2000, Asawalam *et al.,* 2007, Okrikata and Anaso, 2008 who all reported that botanicals gave similar and sometimes even better level of control when compared to synthetic insecticides. The comparatively better performance observed on sorghum plants treated with Finesand formulated botanicals, may be attributed to the abrasive property of Finesand which abrade the cuticles of the stemborers and/or impede their gnawing activity (David and Gardiner, 1950, Hassall, 1990 and Lale, 2002).

The economic analysis in both years shows that the highest expensis (#16,000) was incurred in applying CPP, followed by Sevin Dust - 85% (#15,000) while the least was NKP + Finesand (#7,500) with their corresponding cost: benefit ratios as (1:2.57, 1:2.53), (1:2.48, 1:2.40) and (1:5.76, 1:5.48) in 2009 and 2010, respectively. Worthy of note also is that, though CPP cost more than Sevin Dust – 85%, but because CPP gave a higher yield than the Sevin, it has a slightly higher cost: benefit ratio (1:2.57 and 1:2.53) than Sevin Dust – 85% (1:2.48 and 1:2.40) in both years, respectively.

Overall and in both years, respectively; NKP + Finesand gave the highest cost: benefit ratio (1:5.76 and 1:5.48), followed by CPP + Finesand (1:4.36 and 1:4.29). followed by NKP (1:4.17 and 1:4.05), followed by CPP (1:2.57 and 1:2.53) and, the least is Sevin Dust -85% (1:2.48 and 1:2.40). However, the fact that all of them gave a ratio of above one (>1) indicates that profit can be made by using any of them. This means that all the insecticides used are economically viable with the highest being NKP + Finesand and the least, Sevin Dust – 85%.

Generally, the cost for labour associated with collecting/purchasing and preparing botanicals makes their cost close to and sometimes even more than purchasing and using synthetic insecticides (Ngbede *et al.,* 2014). Meanwhile, Amoabeng *et al.,* 2014 reported that in several parts of the developing world, many resource poor farmers do not have the financial strength to purchase synthetic insecticides or commercially formulated botanicals but have free and adequate labour to prepare and use the botanicals no matter the labour requirement. This set of farmers, will certainly find the use of locally prepared botanicals more convenient. On the other hand, Leatemia, 2003 reported that less economic benefit may be derived from the use of botanicals due to labour cost involved in their collection, preparation and application. The results of the economic analysis in this research however shows that apart from CPP which cost #16,000, the other botanical formulations used cost less than the synthetic which cost #15,000. Labour cost within the study area for collecting, preparing and application of the botanicals and also for the application of the synthetic was relatively cheap and adequate and that must have drastically cut down the expensis associated with the botanicals.

Table 1: Relative Performance of Chilli Pepper and Neem Based Botanicals Vis-à-vis Sevin Dust (85%0 in Checking Stemboring by Lepidopterous Stemborers on sorghum and their Cost Benefits in 2009

Treatment	Stem Bored (%)	Number of Holes per Stem	Grain Yield (Kg/ha)	Increase over Untreated Control (%)	Cost of Application of Insecticides (#)	Gross Income (#/ha)	Benefit (#/ha)	Benefit over Untreated Control (#/ha)	Cost:Benefit Ratio
CPP	9.00 (17.05)	1.38	2028	27.13	16,000	152,100	136,100	25,100	1:2.57
CPP + Finesand	8.50 (16.85)	1.26	2032	27.17	9,500	152,400	142,900	31,900	1:4.36
NKP	8.00 (16.35)	1.25	2036	27.31	10,000	152,700	142,700	31,700	1:4.17
NKP + Finesand	7.50 (15.94)	1.24	2056	28.02	7,500	154,200	146,700	35,700	1:5.76
Sevin Dust (85%)	11.00 (19.38)	1.87	1976	25.10	15,000	148,200	133,200	22,200	1:2.48
Untreated Control	33.50 (34.98)	2.89	1480		-	111,000	111,000		-
Mean	20.09	1.65	1934						
SE(±)	1.18	0.11	66						
LSD	3.45*	0.38*	193*						

Cost- Benefit ratio based on #75/kg; the average cost of Sorghum grain in Potiskum Market in 2010
Figures in parenthesis are arc-sine transformed values
* Significant at $p<0.05$

Table 2: Relative Performance of Chilli Pepper and Neem Based Botanicals Vis-à-vis Sevin Dust (85%0 in Checking Stemboring by Lepidopterous Stemborers on sorghum and their Cost Benefits in 2010

Treatment	Stem Bored (%)	Number of Holes per Stem	Grain Yield (Kg/ha)	Increase over Untreated Control (%)	Cost of Application of Insecticides (#)	Gross Income (#/ha)	Benefit (#/ha)	Benefit over Untreated Control (#/ha)	Cost:Benefit Ratio
CPP	9.50 (17.86)	1.78	2032	26.57	16,000	152,400	136,400	24,500	1:2.53
CPP + Finesand	8.50 (16.85)	1.47	2036	26.72	9,500	152,700	143,200	31,300	1:4.29
NKP	8.50 (16.85)	1.52	2032	26.57	10,000	152,400	142,400	30,500	1:4.05
NKP + Finesand	7.50 (15.85)	1.21	2040	26.86	7,500	153,000	145,500	33,600	1:5.48
Sevin Dust (85%)	12.00 (20.14)	2.25	1972	24.34	15,000	147,900	132,900	21,000	1:2.40
Untreated Control	34.50 (36.18)	3.34	1492		-	111,900	111,900		-
Mean	20.62	1.93	1934						
SE(±)	1.21	0.38	65						
LSD	3.63*	0.57*	194*						

Cost- Benefit ratio based on #75/kg; the average cost of Sorghum grain in Potiskum Market in 2010
Figures in parenthesis are arc-sine transformed values
* Significant at $p<0.05$

CONCLUSION

From this study, some important conclusions can be drawn. Firstly, the synthetic insecticide (Sevin Dust – 85%),

Chilli Pepper and Neem based pesticidal powdered formulations were significantly ($p<0.05$) effective over the untreated control in reducing stemboring by stemborers on the target crop (sorghum). Secondly, the grain yield were also significantly ($p<0.05$) higher on the treated plots over the untreated. Worthy of note also is that there was no significant ($p<0.05$) difference between the botanicals and the synthetic (Sevin 85%) in terms of grain yield. Thirdly, the economic analysis shows that, it can be profitable to use any of all the insecticides used in this research in checking stemborers on sorghum. However, it was clearly beneficial to use NKP + Finesand.

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