Ethnobotanical Leaflets 14: 479-90, 2010.

Biocidal Activities of Some Tropical Moss Extracts Against Maize Stem Borers

[1]Ande, A. T*., [1]Wahedi, J. A., and [2]Fatoba, P. O.

[1]Department of Zoology, University of Ilorin, Ilorin, Nigeria
E-mail: andeolu@yahoo.com

[2]Department of Plant Biology, University of Ilorin, Ilorin, Nigeria
E-mail: pofatoba57@yahoo.com

Issued April 1, 2010

Abstract

Solutions of four moss powders, namely: *Calymperes afzelii* Sw., *Thuidium gratum* (P. Beauv.) Jaeg., *Bryum coronatum* Schwaegr. and *Barbula lambarenensis* (Hook) Spreng., were evaluated for insecticidal activity against maize stem borers. The aqueous solutions were smeared periodically on mature maize plants in the field. All mosses tested showed some toxic activity against the established maize stem borers, deterrence regarding further infestation and some influence on the distribution of the borers. *C. afzelii* and *B. coronatum* showed encouraging toxic activities, deterrent activities and promptness that were better or just as good as with Tricel, the control inorganic insecticide. The order of activity of the moss solutions was *C. afzelii> B. coronatum >T. gratum= B. lambarenensis.* The incidence of stem borer in the most preferred internode, i.e. III, was reduced significantly by *C. afzelii, T. gratum* and *B. coronatum* treatments, while *B. lambarenensis* like, Tricel, restricted the incidence of borer holes to internodes III and IV. The advantages proffered by the window of utilizing mosses as pesticide, namely: availability, safety, low cost, ease of application, as well as, the disadvantages, i.e. laborious serial repetitions, was highlighted.

Key words: Mosses, Bio pesticides, Maize, Stem borer.

Introduction

Maize, *Zea mays*, a principal source of human and livestock dietary carbohydrate and industrial substrate (Arannilewa, 2007), faces considerable challenges occasioned by insect pest activities on the field and in storage. Stem borers constitute a major insect pest of maize on the field. Maes (1998) listed 28 stem borer species of which *Buseola fusca* Fuller, *Sesamia calamistis* Hampson and *Eldana saccharina* Walker are most prominent. They attack young maize plants by boring into the stems causing lodging, dead heart, tunnelling and girdling that may cause stem breakage (Kfir, 2000). Yield losses occasioned by stem borer infestation have been reported to range from 10 to 100% in South Western Nigeria (Usua 1968) and the damage escalates with the late season crop (Adeyemi *et al*., 1996; IITA, 1986; Mutsaers, 1991). Enhancing maize productivity on the field, therefore requires the control of stem borer activities. Various control tactics have been employed. The most popular being the chemical method which relies heavily on the use of synthetic insecticide and fumigants. This unfortunately is costly, toxic to its users, presents undesirable effects on non-target organisms, aids development of resistant strains and are generally not environmentally friendly (Jembere *et al*.,1995; Okonkwo and Okoye,1996). Bio pesticides, on the other hand, are known to be more environmentally safe, users and consumers friendly and specific with broad spectrum bioactivity. Sourcing of promising bio pesticide principles against insect pests from plants has over the years become quite popular (Anon, 1991). Neem derivatives for instance have been effective in control of stem borers (Aliniazee *et al*., 1997; Kumar and Bhatt, 1999; Ganguli and Ganguli, 1998; Bhanukiran and Panwar, 2000). Water extract of fresh neem leaves gave a good control of maize stem borer when applied into the plant whorls in Mozambique (Segenren, 1993). A disproportionately higher attention has been given to spermatophytes, despite the well documented bactericidal, insecticidal, antiviral and fungicidal activities of bryophytes (Banerjee and Sen, 1979; Ando and Matsuo, 1984; Hans *et al*., 1988; Fatoba *et al*., 2003). Seigler

(1998) excused this on the presence of secondary metabolites in the *mosses.* An attempt to investigate four common tropical mosses, viz: *Calymperes afzelii, Thuidium gratum, Bryum coronatum* and *Barbula lambarenensis,* for biocidal activities against maize stem borers is reported for the first time.

Materials and Methods

Fresh samples of four mosses, i.e. *Calymperes afzelii* Sw., *Thuidium gratum* (P. Beauv.) Jaeg.and *Bryum coronatum* Schwaegr. were collected from their natural populations on oil palm trees on the main campus of Adeyemi College of Education, Ondo, Nigeria, while *Barbula lambarenensis* (Hook) Spreng. was collected on the surface of a concrete slab on the main campus of the University of Ilorin, Ilorin, Nigeria. The specimens were identified at the Herbarium of the Plant Biology Department of University of Ilorin. All the four specimens were air-dried separately in a dark cupboard to a constant weight. Each was subsequently pulverised using an electric blender and each powder was stored in a dark screw cap bottle. Tricel (Chlorpyriphos, 48%, E.C) a synthetic insecticide procured from an Agro-Chemical store in Ilorin and distilled water were used as treated and untreated controls, respectively.

A clean farm land monocropped with maize, located behind the stadium on the main campus of University of Ilorin was used for the bioassay. Twenty four 2m X 2m plots, each consisting of 4 maize plant stands, were mapped out on the farm land. Four replicate plots were assigned to each of the moss and the two control treatments in a completely randomised design. Weeding, fertilizer application and other farm management practices were applied uniformly across the plots.

Ground powder aqueous solution of each of the four test mosses were constituted by dissolving 5g of the dry pulverized moss sample in $100cm^3$ of distilled water and stirring vigorously. Treated control solution, i.e. Tricel, was constituted as 5% v/v of distilled water. Distilled water was employed as the untreated control.

The respective solutions were smeared on the surface of 2 months old maize plant shoots with the aid of a paint brush. The application was repeated at 3 day interval for three weeks with newly constituted

solution each time. The incidence of borer holes per plot was noted prior to solution application and subsequently before repeating the application, by direct inspection of the maize stems for borer holes. The total number of borer holes noticed was recorded per plot on each inspection and the affected internode noted. Internode on each maize plant stand was tagged I, II, III, and IV starting from the base. Mean stem borer holes were calculated from values recorded from the four replicates and recorded as X ± SD. An attempt was made to determine the living status of the borer at the end of the experiment by opening up the stem carefully to expose the borer. The number of dead stem borer per plot was noted and mean mortality rate per treatment calculated. Additional borer holes noted after the previous borer hole reading was regarded as new recruitments within 3 days of treatment. Mean recruitment rate per plot was calculated as the average of the additional borer holes per plot, and mean recruitment rate/treatment/3 days was calculated as the mean of the seven successive recruitment rates recorded every 3 days of treatment. Values obtained for the various treatments were compared statistically using ANOVA. A *P*-value of less than 0.05 was considered significant.

Results and Discussion

The successive incidence of borer holes on 2 month old maize plant stands in the various treatments plans are as shown in Table 1. The mean number of borer holes on the untreated maize plant stands increased steadily from 2.00±1.63 to 6.00±3.16 during the three weeks of application. Tricel (control) was prompt and effective, as it prevented increase in stem borer holes after the third application. All the moss treatments stalled the increase of borer holes completely by the third or fourth application. The performance of *C. afzelii* was better than Tricel(Control) as it was effective by the second application. *T. gratum* and *B. lambarenensis* delayed activity until after the fourth application. The third application of *B. coronatum* gave the desired effectiveness thus making it as active as Tricel. The total number of stem borers recruited during the three weeks of exposure to the various treatments (Table 2) showed that all moss treatments and Tricel recruited encouragingly lower stem borers than

the 16 recorded with distilled water control treatment. *C. afzelii* recruited the lowest number of stem borers, i.e. 2, Tricel and *B. coronatum* recruited 3 and 4, respectively, while *B. lambarenensis* and *T. gratum* treatments recruited relatively higher numbers of 6 and 7, respectively. As expected, the mean number of recruitments per plot followed the same trend, A statistical comparison of the respective values however, showed that *C. afzelii*, Tricel and *B. coronatum* recruitments were not significantly different ($P>0.05$) from one another, but significantly lower ($P<0.05$) than recruitments of *B. lambarenensis* and *T. gratum* that were not significantly different $P>0.05$).The mean three-day recruitment rate was generally low and conformed with the trend of recruitments. All the mosses and Tricel control treatments recorded a mean recruitment rate of less than 0.3 borer holes in three days as against approximately 2.0 with untreated control.

Stem borer mortality (Table 2) was generally quite high as 54.17% was noticed on the untreated maize stands. There was, however, an evidence of improved mortality with all the mosses and Tricel treatments. A distinctly higher mortality of 80% was noticed with *C. afzelii*, while *B. coronatum* and Tricel gave a comparable mortality values control of about 77%, and *T. gratum* and *B. lambarenensis* recorded lower but comparable values of about 65%.

Table 3 shows that stem borer hole distribution is generally restricted to the internodes II, III and IV, but more readily found on III. This was the case with *C. afzelii, T. gratum* and *B. coronatum* treatments, but the numbers recorded were distinctly lower than untreated control. Tricel and *B. lambarenensis*, however, deterred the occurrence of borer holes on internode II but internode III still had a relatively higher number of holes than II. Only the numbers noticed on internodes III showed significantly different ($P<0.05$) means, with the untreated control mean, i.e. 4.00 ± 1.63, being higher than the mean numbers recorded with moss and Tricel treatments .

The application of moss extracts onto the surface of a mature maize plant improved stem borer mortality, reduced their incidence and recruitment and affected their distribution on the maize plant stands. Similar trends were reported when neem based extracts were applied against *Chilo partellus*, a maize stem borer (Segenren, 1993; Ganguli and Ganguli, 1998; Bhanukiran and Panwar, 2000). Moss

extracts also gave commendable and encouraging productive effects when applied to cowpea on the field (Fatoba and Akolo, In press). The promptness of the moss extracts in this case is particularly note worthy , as *C. afzelii* acted faster, and *B. coronatum* provided the desired action at the same time duration as Tricel, a synthetic inorganic insecticide. The order of promptness was *C. afzelii*> *B. coronatum*= Tricel >*T. gratum= B. lambarenensis.* Also evident was the repulsive activities of all the mosses tested. The sharp drop in the recruitment rates could only be due to a deterrent informed by the presence of the mosses, just as the case was with Tricel. In this case too *C. afzelii* was better than Tricel and *B. coronatum* were just equally effective. Although mortality was generally high, the mosses no doubt had an impact on the mortality of the stem borers with a minimum of 63.64 % recorded with *B. lambarenensis* as against 54.17% in untreated control. Again *C. afzelii* was more toxic to the stem borers than Tricel, while *B. coronatum* had a comparable level of toxicity. The use of moss extract did not influence the preference of the stem borers for internode III. It however reduced the numbers significantly especially with *C. afzelii, T. gratum* and *B. coronatum* treatments. *B. lambarenensis* like Tricel restricted the incidence of borer holes to internodes III and IV.

The moss extracts tested, i.e. *C. afzelii, B. coronatum, T. gratum* and *B. lambarenensis* being bio pesticides are safe and environmentally friendly. They are readily found in the guinea savannah and forest belt of Nigeria. They, for now, do not enjoy any other known economic use and so will be relatively cheap and available. Channelling this important flora resource as effective bio pesticide will no doubt confer an economic advantage to maize production especially the late maize. The ease of application, i.e. smearing on maize plant stands and the safety to the applicant also gives the treatment credence. The repetitive and serial application on each plant stand may be tedious and impracticable. A more practicable regime of application is therefore desired if the mode is to be adopted for stem borer control.

In conclusion, moss extracts no doubt holds some promise in respect of the control of stem borer infestation on maize. The fact that they are prompt, toxic, cheap, readily available and environmentally

friendly make them good candidates for further investigation as stem borer deterrents.

References

Adeyemi, S. A. O., Donelly, J. and Odetoyinbo, J. A. (1996). Studies on chemical control of the stem borer of maize. *Nigerian Agricultural Journal* **3**:61-66.

Aliniazee , M.T., Alhumeyri, A. and Saeed, M. (1997). Laboratory and field evaluation of a neem insecticide against *Archips rosanus* L. (Lepidoptera:Tortricidae). *Canadian Entomol*., **129**:27-33.

Ando, H. and Matsuo, A. (1984). Applied Biology. *Advances in Bryology*. **2** : 133-224.

Anon. (1991). Recommendations of the symposium on resources for sustainable agriculture: The use of neem and other plant materials for pest control and rural development. *Neem Symposium XVII Pacific Science Congress* (Honolulu: East West Centre). pp 1-11.

Arannilewa, S. T. (2007). A simple laboratory pre-screen for plants with grain protectant effects against the maize weevil; *Sitophilus zeamais* (Mots.) (Coleoptera: curculionidea). *Agricultural Journal* **2**(**6**): 736-739.

Banerjee, R.D. and Sen, S.P. (1979). Antibiotic activity of bryophytes. *The Bryologist*, **82**: 141-153.

Bhanukiran, Y. and Panwar, V.P.S. (2000). *In vitro* efficacies of neem products on the larvae of maize stalk borer *Chilo partellus* (Swin.). *Ann. Pl. Protect. Sci*., **8** : 240-242.

Fatoba, P. O., Omojasola, P. F., Awe, S and Ahmed F. G. (2003). Phytochemical screening of some selected tropical mosses. *NISEB Journal,* **3(2)**: 49-52.

Fatoba, P. O. and Akolo, R. In press. The effects of some cryptogrammic extracts on the primary

productivity of *Vigna unguiculata* L. Walp. *African Journal of Plant Sciences*

Ganguli, R.N. and Ganguli, J. (1998). Residual toxicity of insecticides and neem based formulations against *Chilo partellus* (Swin.) infesting maize. *Indian J. Agric. Res,* **32**:227-232.

Hans, D., Zinsmeister, A. and Rudigermus, L. (1988). Bryophytes as a reservoir of remarkable secondary components. A plant research and development. *German Contributions and Developments Via Plant Research* **27**: 12 – 28.

IITA (1986). Maize Research program. International Institute of Tropical Agriculture, Annual Report for 1986.IITA, Ibadan, Nigeria.

Jembere, B., Obeng-Ofori, D., Hassanali, A., Nyamasoyo, G.N.N. (1995). Products derived from the leaves of *Ocimum kilimandscharicum* (Labiatae) as post-harvest grain protectants against the infestation of three major stored product insect pests. *Bulletin of Entomological Research.* **85**:361-367.

Kfir, R. 2000. Seasonal occurrence, parasitoids and parthogens of the African stem borer, *Busseola fusca* (Fuller) (Lepidoptera: Nuctuidae), on cereal crops in South Africa. *Afr. Entomol*. **2**:1-14.

Kumar, S. and Bhatt, R.I. 1999. Field evaluation of plant leaf extracts oil and neem products against mango hopper (*Amritodus atkinsoni* Leth.) and thrips (*Scirtothrips mangiferae* Hood). *Allelopathy J*., **6**:271-276.

Maes. K. 1998. Pyraloidea: Crambidea, pyraloidea. **150:** 87-98.

Mutsaers, H.J.W. 1991. Opportunities for second cropping in South Western Nigeria. RCMP Research Monograph No. 4. Resource and Crop Management Program. International Institute of Tropical Agriculture, Ibadan. 28pp.

Okonkwo, E.U. and Okoye, W.I. 1996. The efficacy of four seed powders and the essential oils as protectants of cowpea and maize grains against infestation by *Callosobruchus maculatus* (Fibricius) (Coleoptera:Bruchidae) and *Sitophilus zeamais* (Motschulsky) (Coleoptera: Curculionidae) in Nigeria. *International Journal of Pest Management*, **42**(**3**): 143-146.

Segenren, P. 1993. Pesticidus natuais: uma alternativa para U sector familiar? Extra-Revista-pars O deslvolvimen e a extensao rural, 12: 34-38- Centro do farmacao Agraria e de Desenvolvimento Rural Maputo, Mocambique.

Seigler, D. J. 1998. Plants with saponins and cardiac glycosides. www. Life.VinC. Edu/ plant bio/363/ saponin slides

Usua, E.J. 1968. The biology and ecology of *Busseola fusca* and *Sesamia* species in South-western Nigeria: Distribution and population studies. *Journal of Economic Entomology* **61**:830-833.

Table 1: Incidence of borer holes on maize stands per plot.

		Mean number of borer holes per plot					
		Distil water	***C. afzelii***	***T. gratum***	***B. coronatum***	***B. lambarenensis***	**Tricel (control)**
On application		2.00 ±1.63	2.00 ±1.41	1.75 ±1.50	2.25±0.96	1.25±0.96	1.50±1.29
After application (Days)	3	3.00 ±2.16	2.50 ±1.29	1.75 ±1.50	2.75±0.96	2.00±1.41	1.75±0.96
	6	3.75 ±1.71	2.50 ±1.29	2.75 ±0.96	3.25±0.96	2.50±1.29	2.25±1.50
	9	4.71 ±1.83	2.50 ±1.29	3.50 ±1.00	3.25±0.96	2.75±1.26	2.25±1.50
	12	4.75 ±2.75	2.50 ±1.29	3.50 ±1.00	3.25±0.96	2.75±1.26	2.25±1.50
	15	5.25 ±2.87	2.50 ±1.29	3.50 ±1.00	3.25±0.96	2.75±1.26	2.25±1.50

	18	5.75 ±3.10	2.50 ±1.29	3.50 ±1.00	3.25±0.96	2.75±1.26	2.25±1.50
	21	6.00 ±3.16	2.50 ±1.29	3.50 ±1.00	3.25±0.96	2.75±1.26	2.25±1.50

Values are means of four replicates

Table 2: Stem borer recruitment and mortality features on maize plant stands treated with four different types of moss extracts and Tricel.

	Distl water	*C. afzelii*	*T. gratum*	*B. coronatum*	*B. lambarenensis*	Tricel (control)
***Total recruitment after 3 weeks**	16.00	2.00	7.00	4.00	6.00	3.00
Mean number of recruitment per plot (borer/plot)	4.00± 1.50^{c}	0.50± 1.25 ^{a}	1.75 ±0.75^{b}	1.00±0.75^{a}	1.50±1.50 ^{b}	0.75±0.75^{a}
Mean recruitment rate (borer/3days)	0.57 ±0.36^{b}	0.07±0.19^{a}	0.25 ±0.43^{ab}	0.14 ±0.24^{ab}	0.21±0.30^{a}	0.11±0.20^{a}
Mortality rate (%)	54.17	80.00	69.23	76.92	63.64	77.78

Values are means of four replicates; * are total for four replicates

Means carrying the same superscript along rows are not significantly different at P=0.05

Table 3: Stem borer distribution on the internodes of maize plant stands treated with four different types of moss extracts and Tricel.

Treatment	Total number of borer holes per plot per internode			
	I	II	III	IV
Distil water (control)	0.00±0.00^{a}	0.50±0.58^{ab}	4.00±1.63^{b}	1.50±1.29^{a}
C. afzelii	0.00±0.00^{a}	0.50±0.58^{ab}	1.25±0.96^{a}	0.75±0.96^{a}
T. gratum	0.00±0.00^{a}	0.50±0.58^{ab}	1.75±0.50^{a}	1.25±0.96^{a}
B. coronatum	0.00±0.00^{a}	0.25±0.50^{a}	1.75±0.50^{a}	1.25±0.50^{a}
B. lambarenensis	0.00±0.00^{a}	0.00±0.00^{a}	1.50±0.58^{a}	1.25±0.96^{a}
Tricel (control)	0.00±0.00^{a}	0.00±0.00^{a}	1.25±0.96^{a}	1.00±0.82^{a}

Values are means of four replicates

Means carrying the same superscript along columns are not significantly different at P=0.05