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Assessment of Damage and Evaluation of Botanicals for Control of Millipede, *Spirostreptus assiniensis* Attems (Diplopoda) on Yam Tuber (*Dioscorea rotundata Poir*)

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Abstract – **Millipede is an important soil pest of yam tuber in Benue State, Southern Guinea savannah ecological zone, Nigeria. Damage by the millipede, *S. assiniensis* on yam tuber was assessed under ambient laboratory temperature of 25°C and 73 2% RH. Adult millipedes were introduced to their substrate in cages with moist soil and observed for exposed period of 24 hrs, 48 hrs, 72hrs, 7days, 14 days and 21 days. Parameters assessed were number, depth and size of feeding holes on yam tubers. Field experiments were also conducted in the 2007 and 2008 wet seasons to evaluate the efficacy of three botanical powders on the arthropod pest and to compare the powders with the synthetic insecticide check. The treatments were replicated four times in randomized complete block design. The botanicals were applied at the rate of 5g/mound at 14 WAP and 16 WAP at the period of new tuber formation. The parameters evaluated were number, depth and diameter of feeding holes. Data collected were subjected to Analysis of Variance using SAS Model 2000 version (8) and means were separated using the least significance difference (LSD) at p=0.05. The Laboratory result showed significant (p<0.05) increase in the number and depth of feeding holes bored in the tubers by the millipede at 14 and 21 days of exposure. The result from the field experiment showed that *Parkia biglobosa* husk powder, *Azadiracha indica* (A) juss leaf and seed powder significantly (p<0.05) reduced the number,depth and diameter of feeding holes created by millipede on tubers compared with untreated tubers. However, *A. indica* leaf powder was the best treatment.This is the first report on the use of botanicals for control of millipede (Diplopoda).**

Keywords – **Damage, Assessment, Millipede, Control, Botanicals, White Yam.**

I. Introduction

Yams are food crops of major importance in tropical agriculture, yam constitutes an average of 32% of farmers' gross income derived from arable crops (Lagemann, 1977). The crop produce the staple food stuff for millions of people in many tropical countries, most notably in West Africa, the Caribbeans and parts of Southeast Asia (Hahn *et al.*, 1987) yams are significant sources of calories, calcium, nicotinic acid, iron, thiamine and ascorbic acid (Vitamin C) which concentrate under the skin (Coursey, 1967).

Yams are attacked by various pests responsible for the suboptimal yields, food market value and deterioration in the quality of tubers in storing.

Millipede (*Diplopoda*) infestation on tuber is becoming more important in the southern Nigeria and little is known about their biology, distribution, economic importance, and control (Wood *et al.*, 1980). Millipede is an important pest of yam in Benue State. Reports on baseline survey (Ayoola *et al* 2006, Okoroafor *et al* 2010) in Benue State revealed severe infestation of millipede on yam in all the localities growing yam in the state.

In Nigeria, three species are known to be pests of crops namely, *Spirostreptus* assiniensis, *Archispirostreptus giga* known as African giant millipede and *Peridontopyge spinossima,* the groundnut millipede, in Nigeria, work on reaction of these millipedes to light, humidity and temperature was reported by Toye (1966), while Lewis (1974) reported on ecology of millipede in Northern Nigeria. However,there was no work reported on damage to yam and possible control in Nigeria.Based on these limitations, this study was conducted to assess damage caused by the millipede on yam tuber and to evaluate efficacy of botanicals on the millipede. Carbofuran was reported effective on millipede (Amatobi, 2007). However, the LD 50 oral dose of 8-14 mg/kg body weight. Categorizes carbofuran in a highly hazardous class of insecticides (Barnthouse *et al,* 1991, Van Schaubroech *et al*, 1992). Bioactive metabolites such as Saponin, Alkaloids, Flavonoids, Cardiac glycoside and Tannin are present in *Parkia* husk (Achide,1987) and these metabolites in other plants were reported effective on some insects. However, there also appears to be no report of *Parkia husk* treatment for the control of millipede. Crude preparations of *A. indica* leaf and seed extract with organic ash was used in this study, and it was difficult to predict the compounds which actually deterred the feeding of *H. meles* on yam tubers treated but existing research findings confirmed the presence of multiple bioactive components and multiple bioactivities associated with crude preparation of neem products. More research findings have revealed the presence of active compounds such as Azadirachtin A, 26-epoxynimbin, 6-acetylacetate, sodium nimbidate in the seed of *A. indica* which were recommended for utilization as pesticide (Gopinathan, 2007) and these could be responsible for the deterred feeding of *millipede* on the tubers. Limonoids such as salanin and nimbin which are related to Azadirachtin are present in the seed to about 1.4% and 0.5% respectively (Govindhachari *et al*,1996). The efficacy of *A. indica* leaf extract might also be attributed to the presence of bioactive components such as vilasinin, 6-Acetylnimbandiol, 6-Deacetylnimbin, 6-Acetylniminene in the leaf recommended for utilization as pesticide (Gopinathan, 2007). I n addition to bitter principles such as Salanin, Nimbin and Nimbinene which are more in the seed kernel followed by the leaf (Jianming Dai *et al*, 2001),

The objectives of this study were to assess damage caused by the millipede on susceptible yam cultivar and to evaluate the efficacy of the botanicals for improved tuber protection from feeding bored holes and tuber losses due to pathogen entry through bored holes.

III. Materials and Method

Laboratory Experiment

The experiment was conducted using plastic strainer cages filled with five hundred grammes (500g) of soil weighed with a chemical balance. The soil was wetted with 100mls of water to create a natural environment. The yam setts cut from susceptible yam cultivar Amula were placed on the wet soil and adult millipedes *S.assiniensis* were introduced into the cages replicated twelve times in completely randomized design. Damage caused on the untreated yam setts was observed for three weeks starting from 24hrs after millipede exposure to the yam and parameters recorded were number of holes, depth and diameter of feeding holes created by the millipedes.

The cages were kept in the laboratory for observation at ambient temperature of 25^0C + 5 and relative humidity of 73% + 2% for 21 days.

Description of Plastic Cage

The cage was made up of a perforated plastic with five pore mesh (0.55mm). The indented sieve has 22cm surface diameter with 6.5cm height which was inverted in the perforated plastic container with surface diameter of 24cm and height of 10cm (plate 1&2).

Field Experiment

Field experiments were conducted at the CEC Adaptive Research Farm, University of Agriculture, Makurdi in 2007 and 2008 wet seasons (Lat $7^0$0'N, Long. $8^0$0E).

Experimental Design, Layout and Treatment:

The fields were cleared of plant debris and the land was marked out into plots. Mounds were made using the indigenous hand hoe. The plot size was $9m^2$ with 1.5m spacing between plots. And 2m spacing between replicates. Each plot consists of nine heaps aligned in three rows.

The treatments comprised of Neem seed powder (NSP), Neem leaf powder (NLP), Parkia husk powder (PHP), Furadan 5G (5% Carbofuran) and a control which were replicated four times in a Randomized complete block design. The weight of seed yam planted was within the range of 250 – 300g. The seed yams were planted first week of May in 2007 and 2008.

The experimental areas were kept weed free by manual weeding with indigenous hand hoe. The weeding commenced at eight weeks and subsequently at 12 and 16 weeks after planting being the critical period of weed interference. Compound fertilizer (N.P.K 20:10 :10) was applied at the rate of 100g/ha at 10 WAP. The neem seed and leaf, Parkia husk powders were formulated with organic ash serving as the spreader and were applied at the rate of 5g active material (a.m) /heap while Furadan 5G was applied at 5g/heap. The botanical insecticides were applied at 14 WAP and 16WAP in the month of August while the synthetic insecticide was applied once at 14 WAP.The first applications were made at the period of new tuber formation.

Sampling and Damage Assessment

Random sampling of three heaps out of nine per plot were carried out from the middle row and two side rows per plot during harvesting in the month of November(26 WAP). The sampled tubers were bagged and labeled according to treatments in the plots and replicates and were assessed for damage caused by the millipedes.

The damaged tubers were assessed for the number of feeding holes created on tubers,depth of feeding,and diameter of holes which were used as damage index.

Statistical Analysis:

Data collected were subjected to the Analysis of Variance using SAS model 2000 Version (8) and differences between means were separated using the least significant difference (LSD) at P = 0.05.

IV. Results and Discussion

Laboratory result on table 1, plates 1and 2 showed significant (P<0.05) increase in the number, depth and diameter of feeding holes bored in the tubers by the millipede at 7 days, 14 days and 21 days of exposure to their substrate in the cages with moist soil that provided natural conditions for their survival, since millipede is hydrophilic (water loving) and geophilic (soil loving) arthropod pest. It was recorded that a single adult millipede created three holes of size 0.81-1.34cm on a tuber within three weeks.These feeding holes are entry points for rot pathogens infection that result to tuber loss in growing and matured tubers in the soil mounds.

The results on table 2 shows the effect of the botanicals on the millipede feeding activities under field condition. The results showed no significant difference (P<0.05) in the reduction of number of holes,depth and diameter of holes in the plots treated with *Parkia biglobosa husk* powder, *Azadirachta indica* leaf and seed powders. The botanicals were comparable with the carbofuran used as a check. However, the values obtained on the number ,depth and diameter of feeding holes from the tubers treated with *A-indica* seed and leaf powders ,*Parkia husk Powder* were superior to the untreated tubers harvested from control plots(Table 2).

The possible reason for the high number of feeding holes in the tubers treated with *P. biglobosa husk* powder may be attributed to the higher number of live millipedes dwelling in mounds in the plots allocated to Parkia husk powder before the soil application of the pesticides commenced.

The results obtained from the application of *P. biglobosa* husk extract showed that *Parkia* husk reduced feeding of millipede on yam tubers. According to the report of (Sabiiti and Cabbina, 1992), *P.biglobosa* contains high tannin and phenolic compounds. The presence of Saponin, Alkaloids, Flavonoids, Tannin and Glycosides in the husk of *P. biglobosa* was also reported by (Achide, 1987).

The 50% concentration of *A.indica leaf* and seed, *P.biglobosa husk* in the formulation with rice hull ash was potent to reduce the millipede damage on the yam tubers. The efficacy of these botanicals is attributed to their deterent effect in their feeding and this is in agreement with the report that bioactive agents in *A.indica* such as salamin and nimbin in the leaves deter feeding of many insects. (Meisner *et al* 1981; Kraus, 2002) while Saponin, tannin, flavonoids, alkaloids present in the Parkia husk (Achide, 1998) are bioactive agents that deterred feeding of insects (Thacker, 2002).

V. Conclusion

The laboratory study revealed that one adult millipede created three holes of sizes 0.81-1.34 cm within three weeks of feeding on untreated yam tuber.

Plate 1: Millipede Feeding in Yam Tuber

It was also recorded that *A. indica leaf and seed* powder applied as soil treatment were best with potency to reduce the sizes of feeding holes on treated tubers. Thus, the *A.indica leaves* and seeds which are readily available all year round can be utilized as potential bioinsecticide for soil treatment against the yam tuber millipede.

Plate 2: Millipede Damaged Tuber

Table 1: Camparison of damage by *S.assiniesis* on yam tuber (*D. rotundata cv Amula*) under periods of observations.

Treatments (Period)	Mean No. of holes (cm)	Mean Depth of holes/tuber	Mean Diameter of holes/tuber
7 wks	1.08	0.47	0.81
14	2.08	1.64	1.27
21	2.25	2.53	1.34
LSD(P=0.05)	0.24	0.96	0.10

Means are values of twelve replicates.

Table 2: Effect of *P.biglobosa husk, A.indica leaf* and seed powders on yam millipede causing damage on yam tuber in 2007 and 2008 cropping seasons.

	2007				2008			
Treatments	NH	DEH	DIH	NLM	NH	DEH	DIH	NLM
Control	7.37	2.30	1.20	5.00	9.68	1.95	0.98	3.75
A. indica leaf	0.50	0.33	0.10	3.75	2.97	0.30	0.52	3.00
A.indica seed	0.62	0.20	0.25	2.75	2.35	0.53	0.75	3.25
P. biglobosa	0.50	0.45	0.52	3.25	4.15	0.58	0.67	5.00
carbofuran	1.72	0.20	0.50	3.00	2.92	0.87	0.83	2.50
SE±	0.05	0.04	0.01	0.10	0.06	0.02	0.01	0.09

Means are values of four replicates. NH = Number of holes per tuber, DEH = Depth of holes per tuber, DIH= Diameter of holes per tuber, NLM=Number of live millipedes per mound.

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