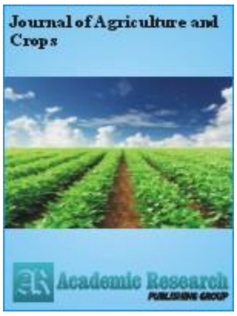
Academic Research Publishing Group



Journal of Agriculture and Crops
ISSN: 2412-6381
Vol. 1, No. 2, pp: 15-25, 2015
URL: http://arpgweb.com/?ic=journal&journal=14&info=aims

Integrated Pest Management of Oryctes Monoceros, Rhynchophorus Phoenicis and Latoia Viridissima in Okomu Oil Palm Plantation, Nigeria

Aneni, T.I.* Entomology division, Nigerian Institute for Oil palm Research, Nigeria
Aisagbonhi, C.I. Okomu Oil palm Company Plc, Nigeria
Ghansah, B. Entomology division, Nigerian Institute for Oil palm Research, Nigeria
Adaigbe V.C. Entomology division, Nigerian Institute for Oil palm Research, Nigeria
Irorere, M.O. Okomu Oil palm Company Plc, Nigeria
Ohweho, G. Okomu Oil palm Company Plc, Nigeria

Abstract: Four, 5-litre Bucket traps containing 9mg/day Oryctes monoceros and Rhynchophorus phoenicis pheromone enhanced with pineapple, impregnated with 20ml of insecticide (Lambdacyhalothrin 2.5 EC) and a control bucket, (without pheromone, pineapple and insecticide) were set up in Okomu oil palm field. This treatment was also replicated, but altered using banana and cut pieces of palm trunks impregnated with same insecticide at the same rate. Oryctes monoceros pheromone traps similarly enhanced, caught 24 weevils while Rhynchophorus phoenicis pheromone traps caught 192 weevils. The trap without pheromone caught nothing. The insects trapped in the pheromone enhanced with pineapple treatment were significantly higher ($P < 0.05$), implying that this treatment was most effective in attracting O. monoceros. In the pheromone traps for R. phoenicis, all the treatments ($P < 0.05$) were effective in attracting R. phoenicis. Traps containing Pheromone + Pineapple + Insecticide + Water recorded highest number of weevils. Microbial Culture of dead Latoia viridissima identified major entomopathogens. This study confirms that pheromone trapping enhanced with fruit substrates are effective in protection of palms from damage caused by Oryctes monoceros and Rhynchophorus phoenicis in Nigeria. This is with least effects on non-target organisms, like useful beneficial insect pollinators and predators. The study identified Penicilium and Aspergillus sp, as major entomopathogens of latoia viridissima and could serve as control agents.

Keywords: Oryctes Monoceros; Rhynchophorus Phoenicis; Pheromone; Fruits; Entomopathogens; Oil Palm.

1. Introduction

Oryctes monoceros (Ol.) has been recorded as a major pest of palms in Nigeria [1, 2] and [3]. When palms are attacked the beetles bore into the young foliage of the central spear and leave characteristic chewed frass at their points of entry. The central spear eventually gets dried up and can be easily pulled off. Palms that recover present scissor – like cuts or wedge – shaped cuts on the foliage. *Oryctes monoceros* often bores into the central spear (young growing foliage) of oil palm and creates entrance holes for *Rhynchophorus phoenicis* to attack the palms. *Oryctes monoceros* thus provides a primary entrance hole for both insects and diseases to attack the palms.

During 1998-1999, the use of cross-cut oil palm stumps for mass trapping the weevils Rhynchophorus phoenicis and Temnoschoita quadripustulata was tested in 11 25-ha oil palm fields at Okomu, Edo state, Nigeria [4]. Pheromone based strategies have been used to manage a number of insect pests [5-7]. Ethyl chrysanthemumate was found to be a strong attractant to *Oryctes*, and Turner [8] suggested baiting traps with this compound, but Wood [9] thought that the density of traps required (25/ha) was too great for the method to be cost-effective . Hallett, *et al.* [10] found that the aggregation pheromone, ethyl-4-methyloctanoate, was ten times more attractive to *Oryctes* than ethyl chrysanthemumate. This allows a much lower trap density, and Chung [11] showed that one trap per 2ha gave good control of damage, provided that the *Oryctes* population was not too large. Oehlschlager, *et al.* [12] described a

*Corresponding Author

pheromone based trapping method for the American palm weevil, *Rhynchophorus palmarum*. Chinchilla, *et al.* [13] showed that after a year of trapping, red ring incidence was reduced by two thirds. Chinchilla, *et al.* [14] showed that pheromone trapping could also be used against *Metamastus hemipterus*. A pheromone produced by the female of *Darna trima* has been identified by Sasaerila, *et al.* [15], who suggested that it could be used to trap males and hence to monitor the population. Desmier de Chenon, *et al.* [16] recommended using pheromone traps for monitoring populations of *Setothosea asigna*. They indicated that this was cheaper than conventional census systems, and might give an earlier warning of pest build up. Rhainds [17] suggested that control should be possible using pheromones to trap males and disrupt mating; this has been done successfully with another bagworm species, *Thyridopteryx ephemeraeformi* [18]. Oehlschlager, *et al.* [19] described the aggregation pheromone of *Rhynchophorus palmarum*. This compound, 'rynchophorol' is released by male weevils, and attracts others of both sexes to the site of release. Pheromones have also been described for *R. phoenicis* [20], *R. ferrugineus* [21] and various other species. Additional attractants include ethyl acetate and ethyl propionate, which are produced by damaged palm tissue, and the most effective traps were baited with the pheromone and palm tissue [20]. Aisagbonhi and Oechlaschlager [22] successfully trapped *Oryctes monoceros* on Date palms and R*hynchophorus phoenicis* on Oil palms in Nigeria. The work on pheromones is summarized by Giblin-Davis, *et al.* [23]. It is therefore imperative to control these major pests of the oil palm in Nigeria.

The nettle caterpillar *Latoia viridissima* Holland (Lepidoptera, Limacodidae) is a major defoliator of palms in West Africa including Nigeria. It has also been recorded from other parts of Africa such as Ivory Coast [24], Cameroun and Uganda [25]. It also attacks other perennial crops such as cocoa [26]. It feeds on mature palm leaflets but the reopened spear and the youngest expanded frond are often avoided. The entire mature leaflets are often consumed leaving only the midrib.

Heavily defoliated stands produce shorter fronds [27] and yield is greatly reduced. Preliminary investigation by Allen and Bull [28] and by other authors showed that up to 90% of palm trees in a plantation may be attached during serious out-break.

The project objective was to determine the effectiveness of pheromone based mass traps for control of *Oryctes monoceros* and R*hynchophorus phoenicis* and to identify major entomopathogens identified as control agents of the *latoia viridissima* on oil palms at Okomu oil palm plantation.

2. Materials and Methods

2.1. Oryctes Monoceros Survey

2.1.1. Study Site

The study sites were fields C11 and D1.1, which were young oil palm 25 hectare plots planted in 2010. Each treatment was laid at every 10th row and hung on a metal suspension. 20ml of insecticide (Lambdacyhalothrin 2.5EC) was poured into 300ml water in each treatment apart from the control.

2.1.2. Treatments

A – Pheromone (P) + 20ml Insecticide in 300ml of water
B - Pheromone (P) + 20ml Insecticide 20ml + Palm trunk cuttings
C – Pheromone (P) + 20ml Insecticide + Pineapple cuttings
D – Pheromone (P) + 20ml Insecticide + Banana cuttings
E – 300ml of water without pheromone (Control)

2.1.3. Observations

- Pre-application assessment of *O. monoceros* on trial plot
- Observations were made once a week for 6 weeks after pheromone application.

2.2. Rhynchophorus Phoenicis Survey

2.2.1. Study Site

The study sites were fields F42, F4.2 and G4.2 which were recently clear felled, 25 hectare plots. Each treatment was laid at every 10th row and hung on a metal suspension. 20ml of insecticide (Lambdacyhalothrin 2.5EC) was poured into 300ml water in each treatment apart from the control.

2.1.2. Treatments

A – Pheromone (P) + 20ml Insecticide in 300ml of water
B - Pheromone (P) + 20ml Insecticide 20ml + Palm trunk cuttings
C – Pheromone (P) + 20ml Insecticide + Pineapple cuttings
D – Pheromone (P) + 20ml Insecticide + Banana cuttings
E – 300ml of water without pheromone (Control)

2.2.3. Observations

- Pre-application assessment of *Rhynchophorus phoenicis* on trial plot
- Observations were made once a week for 6 weeks after pheromone application.

2.3. Pre-application Assessment

2.3.1. Study Site

The study was conducted in fields C1.1, C.12 (planted in 2010); D6.1 (planted in 2011); C.33 and C.34 (planted in 2007). The field consisted of 129 rows (25Ha) of oil palm made up of a total 3, 483 palms at the Okomu Oil Palm Estate, Udo, Edo State, Nigeria. The study area was selected based on initial phytosanitary observations that indicated *Oryctes monoceros* attack on the palms. The survey assessment of the study site was conducted with walk through observations taken at every tenth row at 27 palms per row.

2.4. Assessment of *Latoia viridissima*

2.4.1. Study Site

The study was conducted in field C-23 consisting of 129 rows (25ha) of Oil palm made up of a total of 3483 palms at the Okomu Oil palm estate Udo,Edo State. The study area was selected based on initial phytosanitary observations that indicated *Latoia* larvae attacks on the palms. The survey assessment of the study site was conducted with walk through observations taken at every tenth row at 27 palms per row.

2.5. Microbial Culture of Dead *Latoia viridissima*

2.5.1. Preparation of Stock Solution

Ten millilitres of distilled water were pipetted into three McCartney bottles representing each sample labeled S1, S2, S3 and S4. The bottles were sterilized in an autocalve at 121^0C for 15 minutes. After sterilization, the insects were transferred into the McCartney bottles as a stock solution.

2.5.2. Serial Dilution

Twenty McCartney bottles divided into four groups label10^1 to 10^5 and the stock bottle labeled S1, S2, S3 and S4 prepared in duplicate were sterilized in an autoclave at 121^0C for 15 minutes. The insect's samples were transferred into each individual stock bottle. With a sterile pipette, 1ml each was transferred from the stock bottle into the bottles labeled 10^1 to 10^5 containing nine millilitres of sterilized distilled water for serial dilution preparation.

2.5.3. Pour Plate Technique

One ml of the serial diluted sample was dispensed into a sterilize Petri dish and then already prepared cooled PDA was poured onto the Petri dishes and was to allowed. Petri dishes were incubated on a laboratory bench at laboratory temperature of 28 ± 2^0C for 3-7 days. After the period of incubation, different colonies of fungi associated with the insects were each aseptically subcultured using a flamed inoculating loop, into a sterile plate containing PDA. The morphological features of the organisms were visibly observed.

2.5.4. Morphological Identification of Isolates

Fungal cultures were examined for characteristic macroscopic and microscopic features by comparison with the descriptions and illustrations of Barnett and Hunter [29].

2.5.5. Statistical Analysis

Data was analyzed by one way Analysis of variance and paired sample t-test; and testing for significant difference in the effect of pheromone on *Oryctes monoceros* and *Rhynchophorus phoenicis*.

3. Results and Discussion

3.1. Oryctes Monoceros and Rhynchophorus Phoenicis Analysis

In the pre-application assessment, all fields surveyed were observed to have been attacked by *Oryctes monoceros* attack with fields C.11 (61 palms) and C.34 (161 palms) being the most attacked.

Table-1. Incidence of *Oryctes monoceros* attack on palm fronds in field C.11 (2010 planting)

Rows	Number of Palms Attacked
Row 10	15
Row 30	3
Row 50	12
Row 60	1
Row 70	11
Row 80	1

Row 90	8
	Continue
Row 100	1
Row 110	8
Row 120	1
Total: 10	**61**

Table-2. Incidence of Oryctes monoceros attack on palms in field C. 12 (2010 planting)

Row	**Number of Palms Attacked**
Row 10	2
Row 20	1
Row 30	2
Row 50	1
Row 60	1
Row 70	1
Row 90	1
Row 100	1
Row 110	5
Total: 9	**15**

Table-3. Incidence of *Oryctes monoceros* attack on palms in field D6.1 (2011 planting)

Rows	**Number of Palms Attacked**
Row 10	11
Row 20	4
Row 50	2
Row 60	2
Row 70	5
Row 100	1
Total: 6	**25**

Table-4. Incidence of Oryctes monceros attack on palms in field C.33 (2007 planting)

Rows	**Number of Palms Attacked**
Row 10	1
Row 30	3
Row 50	1
Row 60	1
Row 70	2
Row 80	4
Row 100	2
Row 110	2
Row 120	2
Total: 9	**18**

Table-5. Incidence of *Oryctes monoceros* attack on palms in field C.34 (2007 planting)

Rows	**Number of Palms Attacked**
Row 10	9
Row 20	12
Row 30	3
Row 40	27
Row 50	6
Row 60	15
Row 70	5
Row 80	25
Row 90	7
Row 100	17
Row 110	11
Row 120	24
Total: 12	**161**

Table 6 and 7 show comparison of pheromone effectiveness and the different treatments on *O. monoceros* and *R. phoenicis* during the period of observation.

The pineapple treatment (P < 0.05) was significant (table 1). This implies that this treatment combination was effective in attracting *O. monoceros*. For the *R. phoenicis*, all the treatments (P < 0.05) were effective in attracting *R. phoenicis* (table 2). This implies that any of the treatments were effective.

Table-6. Comparison of Treatment Effectiveness on number of *O. monoceros*

Treatment application comparison	Mean	T-value	Significance
Phero+Pineapple +insecticide	0.2500	2.304	*0.031
Phero+Trunk +insecticide	0.8333	0.371	0.714
Phero+Banana +insecticide	0.20833	1.310	0.203
Phero+ insecticide	-0.16667	-0.848	0.405
Control (Water alone)	-0.04167	-0.327	0.747

P = 0.05

Table-7. Comparison of Treatment Effectiveness on number of *R. Phoenicis*

Treatment application comparison	Mean	T-value	Significance
Phero+Pineapple +insecticide	1.95833	2.816	*0.010
Phero+Trunk +insecticide	3.41667	4.999	*0.000
Phero+Banana +insecticide	1.45833	2.896	*0.008
Phero+insecticide	2.16667	4.008	*0.001
Control (Water alone)	0.70833	2.815	*0.010

P = 0.05

Summary of *Oryctes monoceros* population in the treatment and control observations is presented in tables 8 - 11. It was observed that traps containing treatment A (Pheromone + Pineapple + Insecticide + Water) recorded highest number of beetles (table 8) while the traps containing treatment B (Pheromone + Banana + Insecticide + Water) recorded lowest number of beetles (table 9). No insect was recorded in the control trap during the duration of the study. This is attributed to the absence of pheromone. The beetles were randomly distributed throughout the observation period.

Table-8. Observation of *Oryctes monoceros* in Field C11 after Treatment (Pheromone + pineapple + Insecticide + Water)

Date	Trap 1	Trap 2	Trap 3	Trap 4	Control	Total
13/6/14	1	0	1	1	0	3
20/6/14	0	1	1	0	0	2
27/6/14	1	1	0	0	0	2
4/7/14	1	1	0	0	0	3
11/7/14	0	1	0	0	0	1
18/7/14	0	0	0	0	0	0
						10

Table-9. Observation of *Oryctes monoceros* in Field C11 after Treatment (Pheromone + Banana + Insecticide + Water)

Date	Trap 1	Trap 2	Trap 3	Trap 4	Control	Total
13/6/14	0	0	0	0	0	0
20/6/14	1	0	0	0	0	1
27/6/14	1	1	0	0	0	2
4/7/14	0	0	0	0	0	0
11/7/14	0	0	0	0	0	0
18/7/14	0	0	0	0	0	0
						3

Table-10. Observation of *Oryctes monoceros* in Field D1.1 after Treatment (Pheromone + Trunk + Insecticide + Water)

Date	Trap 1	Trap 2	Trap 3	Trap 4	Control	Total
13/6/14	0	0	0	0	0	0
20/6/14	0	0	0	0	0	0
27/6/14	0	0	0	0	0	0
4/7/14	0	0	0	0	0	0
11/7/14	0	0	0	0	0	0
18/7/14	1	1	1	4	0	7
						7

Table-11. Observation of *Oryctes monoceros* in Field D1.1 after Treatment (Pheromone + Insecticide + Water)

Date	Trap 1	Trap 2	Trap 3	Trap 4	Control	Total
13/6/14	0	0	0	0	0	0
20/6/14	0	0	0	0	0	0
27/6/14	0	0	1	2	0	3
4/7/14	0	0	0	0	0	0
11/7/14	0	0	0	0	0	0
18/7/14	1	0	0	0	0	1
						4

Summary of *Rhynchophorous phoenicis* population in the treatment and control observations is presented in tables 12 - 15. The traps containing treatment A (Pheromone + Pineapple + Insecticide + Water) recorded highest number of beetles (table 12) while the traps containing treatment D (Pheromone + Insecticide + Water) recorded lowest number of beetles (table 15). No insect was recorded in the control trap during the duration of the study. This is attributed to the absence of pheromone. The beetles were randomly distributed through out the observation period. A higher population of *R. phoenicis* were observed to have been trapped than the *O. monocerus* beetles. This could be attributed to a higher abundance of *R. phoenicis* in the field.

Table-12. Observation of *Rhynchophorus phoenicis* in Field 42 after Treatment (Pheromone + pineapple + Insecticide + Water)

Date	Trap 1	Trap 2	Trap 3	Trap 4	Control	Total
13/6/14	2	4	6	1	0	13
20/6/14	1	11	0	8	0	20
27/6/14	5	3	0	10	0	18
4/7/14	3	3	0	4	0	10
11/7/14	5	4	8	5	0	22
18/7/14	5	9	3	5	0	22
						105

Table-13. Observation of *Rhynchophorus phoenicis* in Field 4.2 after Treatment (Pheromone + Banana + Insecticide + Water)

Date	Trap 1	Trap 2	Trap 3	Trap 4	Control	Total
13/6/14	2	4	4	4	0	14
20/6/14	1	6	2	0	0	9
27/6/14	0	5	0	6	0	11
4/7/14	0	0	1	10	0	11
11/7/14	2	3	4	0	0	9
18/7/14	0	1	0	3	0	4
						58

Table-14. Observation of *Rhynchophorus phoenicis* in Field G4.2 after Treatment (Pheromone + Trunk + Insecticide + Water)

Date	Trap 1	Trap 2	Trap 3	Trap 4	Control	Total
13/6/14	4	2	3	1	0	10
20/6/14	1	1	1	1	0	4
27/6/14	1	0	1	1	0	3
4/7/14	1	0	1	2	0	4
11/7/14	1	0	1	0	0	2
18/7/14	0	0	0	0	0	0
						23

Table-15. Observation of *Rhynchophorus phoenicis* in Field G4.2 after Treatment (Pheromone + Insecticide + Water)

Date	Trap 1	Trap 2	Trap 3	Trap 4	Control	Total
13/6/14	0	2	0	0	0	2
20/6/14	0	0	0	0	0	0
27/6/14	0	0	0	0	0	0
4/7/14	0	1	0	0	0	1
11/7/14	0	2	0	0	0	2
18/7/14	0	1	0	0	0	1
						6

Variation in number of *O. monoceros* and adult in the treatment and control observations is presented in figures 1 and 2. Comparison of *R. phoenicis* and *O. monoceros* abundance and distribution in the treatment and control observations is presented in figure 3. Week 3 and 6 had the highest abundance of *O. monoceros* (Fig. 1) while week 1 and 5 had the highest abundance of *R. phoenicis* (Fig. 2).

Comparison of *R. phoenicis* and *O. monoceros* abundance indicates that *R. phoenicis* had a higher population through out the duration of the study. Figure 4 shows one of the pheromone based bucket traps hung on an Iron pole in the field, while Figures 5 and 6 indicate the adult recoveries of *Rhynchophorus phoenicis* and *Oryctes monoceros* respectively.

Fig-1. Shows total numbers of *O. monoceros*

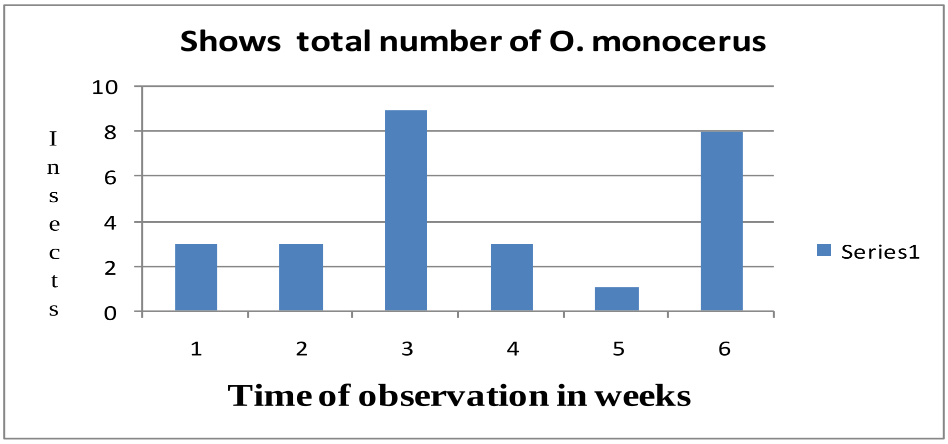


Fig-2. Shows total numbers of *R. phoenicis*

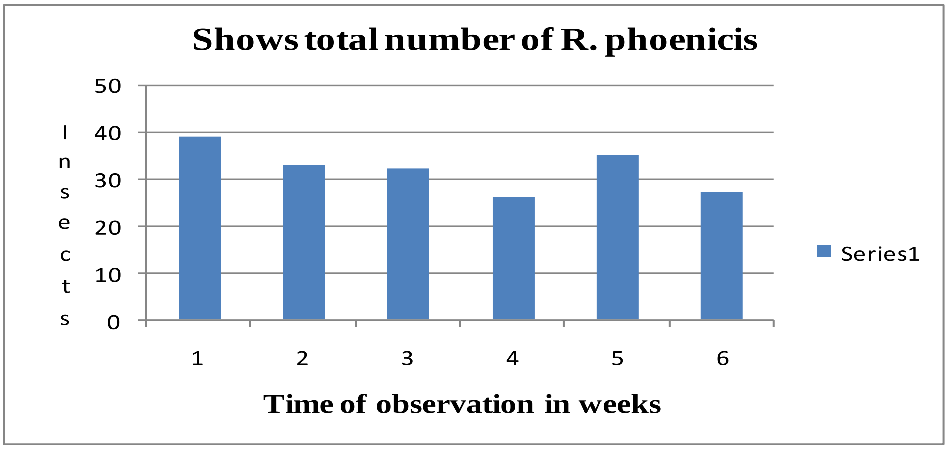


Fig-3. Comparison of *R. phoenicis* and *O. monoceros* numbers

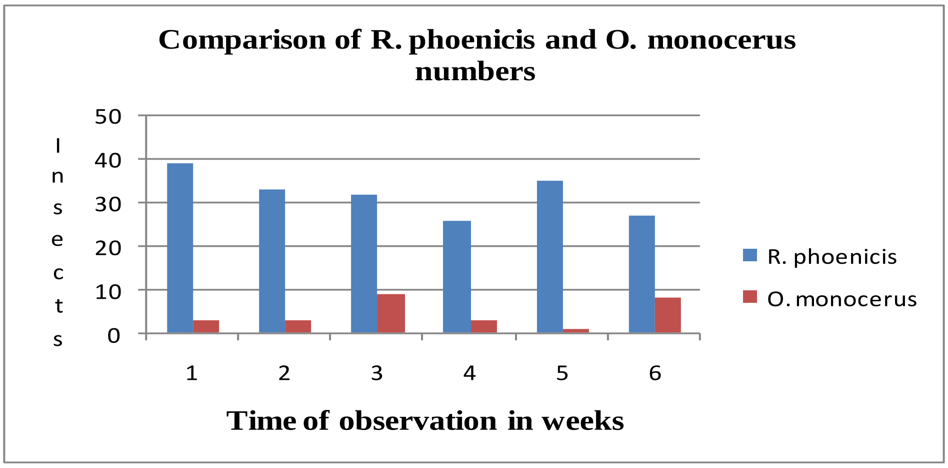


Fig-4. Pheromone bucket trap set up in Okomu Oil Palm Field

Fig-5. Recoveries of Adults *Rhynchophorus phoenicis* from pheromone – bucket based traps

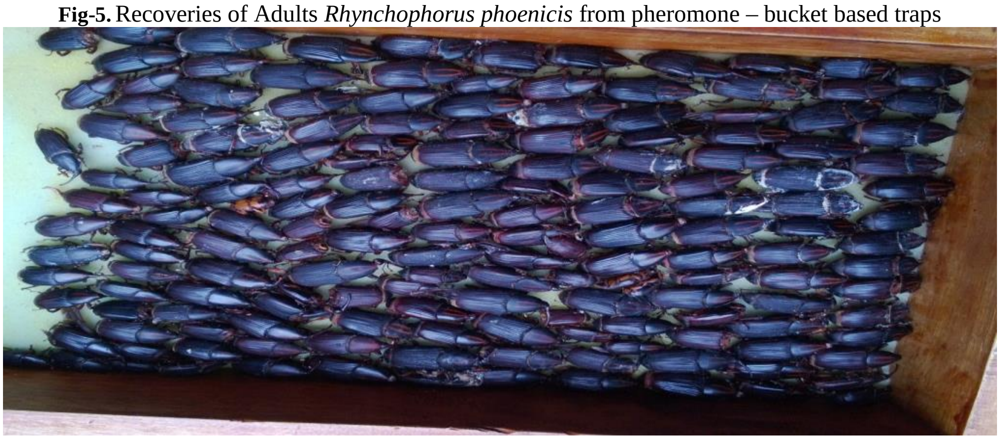
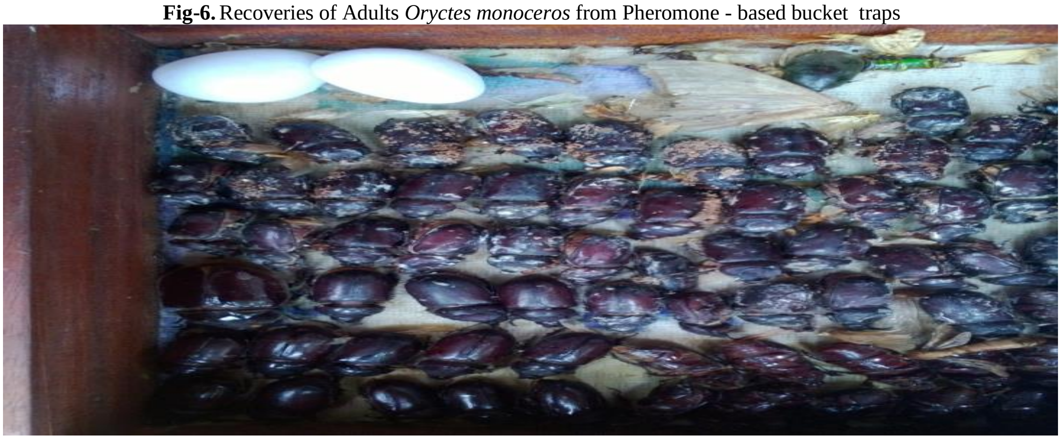


Fig-6. Recoveries of Adults *Oryctes monoceros* from Pheromone - based bucket traps



Latoia Viridissima Results

Table-1. Incidence of Latoia virridissima larvae attack on palms

Row	Number of Palms Attacked
1	0
2	1
3	0
4	0
5	0
6	0
Total: 6	**1**

Table-2. Morphological description of micro-organisms isolated from *L. viridissima*

Samples	Morphological description	Suspected organisms
A	Black mycelia growth	*Aspergillus* sp
	Grey mycelia growth	*Penicillium* sp
	Orange colour mycelia growth	*Aspergillus* sp
B	Grey mycelia growth	*Penicillium* sp
	Orange colour mycelia growth	*Aspergillus* sp
C	Black mycelia growth	*Aspergillus* sp
	Grey mycelia growth	*Penicillium* sp
	Orange colour mycelia growth	*Aspergillus* sp

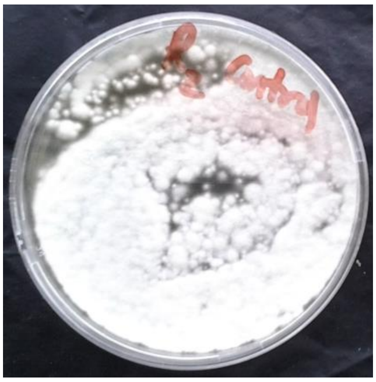


Plate: A

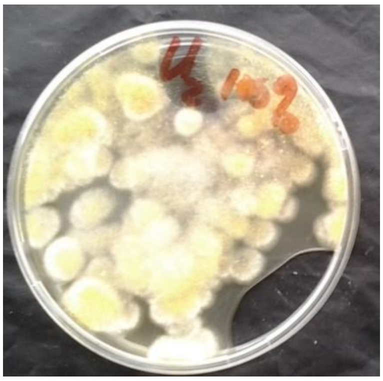


Plate: B

Plate: C

Table 2 shows descriptions of culture plates of microorganisms isolated from insect samples (A= Penicilium sp, B= Aspergillus sp, C= *Aspergillus* sp) grown on Potato dextrose agar under ambient room temperature for three days.

Bacterial, fungal and viral epizootics have been reported on limacodids mostly by workers in Malaysia and South East Asia Gentry [30]. There have been similar reports of epizootics on other lepidopterous insects which are documented in literature [31, 32]. The result of the isolation of *Aspergillus sp.* and *Penicillium sp.* from larvae of *L. viridisima* compare closely with those of other workers. *Aspergillus sp.* isolated in this study have previously been observed by Smith [33] and Hermandez-Crespo and Santiago-Alvarez [34] with significant frequent incidence rates. Kurian [35] reported that *Aspergillus sp* contributed to the natural control of *Macroplectranararia* (Limacodidae) in India during rainy season. Igbinosa [36] also found five parasite species parasitizing the larvae of *L. viridissima* and five different species of parasites were also recorded from the pupae.

The high fungal infection incidence recorded on *L. viridissima* larvae suggests that the fungi entomopathogens isolated are important pathogens associated with the population of the insect.

4. Conclusion

It was observed that the treatment A (Pheromone + Pineapple Insecticide + Water) had the highest population of trapped insects for both *O. monoceros* and *R. phoenicis* during the duration of the study. It can be deduced that the addition of appropriate food substrates aids pheromones in the trapping and attraction of beetles and the weevils.

This study confirms that pheromone trapping enhanced with appropriate substrates enhances protection of palms from damage caused by *Oryctes monoceros* and *Rhynchophorus phoenicis* in Nigeria. This is with least pollutive effects, without reduction in the presence of other beneficial insects pollinators and natural enemies.

This study identified Penicilium and *Aspergillus* sp, as major entomopathogens isolated from *latoia viridissima* and could serve as control agents.

Acknowledgement

We are grateful for the financial provision made for this project by the Managing Director, Agricultural coordinator and Okomu Oil palm Company management. We are also grateful to the Executive Director, NIFOR, for his approval and logistics support.

References

[1] Agwu, S. I., 1983. "The occurrence and breeding sites of Oryctes monoceros (Coleoptera: Dynastidae) " *Nig. Inst. Oil Palm Res.*, vol. 6, pp. 389-399.

[2] Aisagbonhi, C. I., 1989. "Insects associated with the date palm Phoenix dactilifera L. in Nigeria with particular reference to pests of the fruits." Ph.D., University of Benin.

[3] Aisagbonhi, C. I. and Kolade, K. O., 1994. "A survey of insects associated with coconut palm in NIFOR Benin with emphasis on possible vectors of Bronze Leaf Wilt ('Awka wilt')." *Dis. Principles,* vol. 38, pp. 95-99.

[4] Irorere, M. O., Aisagbonhi, C. I., Harvard, T. J., and Enobakhare, D. A., 2000. "Mass trapping of Rhynchophorus phoenicis Fabricius and Temnoschoita quadripustulata Gyllenhall on oil palm trunks at Okomu, Edo state, Nigeria." *Nigerian Journal of Entomology,* vol. 17-18, pp. 39-49.

[5] Novak, M. A. and Roelofs, W. L., 1985. "Behavior of male redbanded leafroller moths, Argyrotaenia velutinana (Lepidoptera: Tortricidae), in small disruption plots." *Environ. Entomol.,* vol. 14, pp. 12-16.

[6] Carde, R. T. and Minks, A. K., 1995. "Control of moth pests by mating disruption: Successes and constraints." *Annu. Rev. Entomol.,* vol. 40, pp. 258-267.

[7] El-Sayed, A. M., Suckling, D. M., Wearing, C. H., and Byers, J. A., 2006. "Potential of Mass trapping for long term pest management and eradication of invasive Species." *J. Econ. Entomol.,* vol. 99, pp. 1550-1564.

[8] Turner, P. D., 1973. "An effective trap for Oryctes beetle in Oil Palms." *Planter.* , vol. 49, pp. 488-490.

[9] Wood, B. J., 1976a. *Pest-Introduction and Ecological Considerations. In: Oil Palm Research. Developments in Crop Science (1). Eds. R.H.V. Corley, J.J. Hardon and B.J. Wood*. Amsterdam: Elsevier Scientific Publishing Company.

[10] Hallett, R. H., Perez, A. L., Gries, G., Gries, R., Pierce, H. D., Yue, J., Oehlschlager, A. C., Gonzalez, L. M., and Borden, J. H., 1995. "Aggregation pheromone of Coconut rhinoceros beetle, Oryctes rhinoceros (L.) (Coleoptera: Scarabaeidae)." *J. Chem. Ecol.,* vol. 21, pp. 1549-1570.

[11] Chung, G. F., 1997. "The bioefficacy of the aggregation pheromone in mass trapping of Rhinoceros beetles (Oryctes rhinoceros) in Malaysia." *Planter, Kuala Lumpur,* vol. 73, pp. 119-127.

[12] Oehlschlager, A. C., Chinchilla, C. M., Gonzalez, L. M., Jiron, L. F., Mexzon, R., and Morgan, B., 1993. "Development of a pheromone based trapping system for Rhynchophorus palmarum (Coleoptera: Curculionidae)." *J. Econ. Entomology,* vol. 86, pp. 1381-1392.

[13] Chinchilla, C. M., Oehlschlager, A. C., and Gonzalez, L. M., 1995. "Management of the red ring Disease in oil palm through pheromone-based trapping of Rhynchophorus Palmarum(L). In: Proc. 1993 PORIM Int. Palm Oil Congr. – Agriculture (Ed. B.S. Jalani et al.), Palm Oil Res. Inst. Malaysia, Kuala Lumpur."

[14] Chinchilla, C. M., Oehlschlager, A. C., and Bulgarelli, J., 1996. "A pheromone-based trapping system for Rhynchophorus palmarum and Metamastus hemipterus." *ASD Oil Palm Papers,* vol. 12, pp. 11-17.

[15] Sasaerila, Y., Gries, R., Gries, G., Khaskin, G., King, S., and Boo, T. C., 2000. "Decadienoates: Sex pheromone components of nettle caterpillars Darna trima and D. bradleyi." *J. Chem. Ecol.,* vol. 26, pp. 1969-1981.

[16] Desmier de Chenon, R., Sipayung, A., and Sinuraya, L., 1996. "Sex pheromone traps for monitoring the limacodid populations of Setithosea asigna in Indonesian Oil Palm plantations." In: Proc. 1996 PORIM Int. Palm Oil Congr. Competiveness For the 21st Century' (Ed. By D. Ariffin et al.) Palm Oil Res. Inst. Malaysia, Kuala Lumpur.

[17] Rhainds, M., 2000. "A review of recent sampling and ecological studies on bagworms (Lepidoptera: Psychidae) in commercial plantations of oil palm." *Planter,* vol. 76, pp. 9-14.

[18] Klun, J. A., Neal, J. W., Leonhardt, B. A., and Schwarz, M., 1986. "Suppression of femal bagworm, Thtridopteryx ephemeraeformis reproduction potential with its Sex pheromone." *J-MPD, Entomol. Exp. Applic.,* vol. 40, pp. 231-238.

[19] Oehlschlager, A. C., Pierce, H. D., Morgan, B., Wimalaratne, P. D., Slessor, K. N., King, G. G., Gries, G., Gries, R., Borden, J. H., *et al.*, 1992. "Chirality and field activity of rhychophorol, the aggregation pheromone of the American palm weevil." *Naturmiss,* vol. 79, pp. 134-135.

[20] Gries, G., Gries, R., Perez, A. L., Oehlslager, A. C., Gonzalez, L. M., Pierce, H. D., Kouda, M., Zebeyou, M., and Nanou, N., 1993. "Aggregation pheromone of the African palm weevil, Rhynchophorus phoenicis." *Naturwissenschaften,* vol. 80, pp. 90-91.

[21] Hallett, R. H., Gries, G., Gries, R., Borden, J. H., Czyzewska, E., Oehlschlager, A. C., Pierce, H. D., Angerill, N. P. D., and Rauf, A., 1993. "Aggregation pheromones of two Asian weevils, Rhynchophorus ferrugineus (oliv.) and R. vulneratus (Panz)." *Naturwissenschaften,* vol. 80, pp. 328-331.

[22] Aisagbonhi, C. I. and Oechlaschlager, A. C., 2006. "Pheromone trapping of two major Pests of palms in Nigeria." *Cord,* vol. 22, pp. 1 – 9.

[23] Giblin-Davis, R. M., Oehlschlager, A. C., Perez, A. L., Gries, G., Gries, R., Weissling, T. J., Chinchilla, C. M., Pena, J. E., Hallet, R. H., *et al.*, 1996. "Chemical and behavioral ecology of palm weevils (Curculionidae: Rhychophorinae)." *Florida Entomologist,* vol. 79, pp. 153-167.

[24] Mariau, D., 1976. *Insect pest in West Africa: In oil palm research (Corley, R.H.Y.; Hardon, I.I. and Wood, B.J., Eds)*: Elsevier Amsterdam.

[25] Hantley, C. U., 1977. *The oil palm*: London Longman Group.

[26] Enwistle, P. F., 1972. *Pest of cocoa*. London: Longman Group.

[27] Young, S. N., 1970. *Some pest of oil palm on the east coast of Sabah: In crop protection in Malaysia*. Kuala Lumpur, Malaysia: 107-115.

[28] Allen, J. O. and Bull, R. A., 1954. " Recent severe attack on oil palm by two Caterpillars belonging to the limacodidae." *J.W. Afr. Oil Palm Res.*, vol. 1, pp. 130-137.

[29] Barnett, H. L. and Hunter, B. B., 1998. *Illustrated genera of imperfect fungi*. 4th ed. St. Paul Minnesota: APS press.

[30] Gentry, P. H., 1972. "Morphologic et biologie de Sibine fasca Stoll. Lepidoptera de foliateur du palmier a Huile en Colombie." *Oleagineux,* vol. 27, pp. 65-71.

[31] Goh, K. S. and Lange, W. H., 1980. "Life tables for the Artichoke flume moth in California." *J.econ. Entomol.,* vol. 73, pp. 153-158.

[32] Ullyett, G. C., 1980. "Mortality factors in populations of plutella maculipennis. Curtise (Tineidae;Lep.) and their relation to the problem of the control." *Mem. Dept. Agric .South Afri.,* vol. 2, pp. 77-202.

[33] Smith, J. J., 1991. "CILSS/DEPV; The permanent interstate committee for drought control in the sahel and the department of crop protection training niger," In *Biological control of Locusts and Grasshoppers. Proceedings of a Workshop held at IITA Cotonou*, Republic du Benin, pp. 30 – 37.

[34] Hermandez-Crespo, P. and Santiago-Alvarez, P., 1997. "Entomopathogenic fungi associated with natural population of the Moroccan Locust. Dociostarus maroccanus (Thumberg) (Orthoptera: Gomphocerinae) and other Acridoidea in Sapin." *Biocontrol Sci. Technol.,* vol. 7, pp. 353-363.

[35] Kurian, C., 1963. "Destructive pests of coconut other than Oryctes rhinoceros." Document F.A.O. Technical working party on Coconut 1961 Bangkok.

[36] Igbinosa, I. B., 1988. "Pathogenecity of three Micro-organisms isolated from the Nettle Caterpillar Latoia viridissima Holland (Lep. Limacodidae)." *Nigerian Journal of Palms and Oil Seeds,* vol. 12, pp. 27-32.