Efficacy of INESPALM insecticide against some major insect pests of oil palm

Technical Report

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EXECUTIVE SUMMARY

INESPALM insecticide is new insecticide that was tested on some major insect pests of oil and coconut palms at Kusi in the Eastern Region of Ghana. The insect pests include the oil palm leaf miner *Coelaenomenodera lameensis*, the oil palm weevil *Temnoschoita quadripustulata*, the brown striped oil palm weevil *Rhynchophorus phoenicis* and the rhinoceros beetle *Oryctes monoceros*. The method used in the application of the chemical was mainly by dipping in the case of laboratory investigation and in one particular case, ingestion by feeding the larvae with treated food. The field investigation involves manual spraying in the case of nursery palms and for the tree palms on the field, through trunk injection. Both laboratory and field investigations show that INESPALM insecticide is effective against all the test insect pests and can be used to control the insect species on oil and coconut farms and plantations.

1.0 Introduction

Oil palm and coconut cultivation and management in Ghana is impacted by many insect activities, some of which are negative, example attack by insect pests which constrain plant growth and production. These include insect pests such as red striped weevil *Rhynchophorus phoenicis* Fabricius, oil palm leafminer *Coelaenomenodera lameensis* Berti and Mariau, Yawson et al., (2006), oil palm weevil *Temnoschoita quadripustulata* Gyllenhall, Yawson et al., (2011) and rhinoceros beetle *Oryctes monoceros* Olivier (Yawson et al., 2008). The oil palm leafminer *C. lameensis* is the key pest of oil palm which can cause disastrous consequences in outbreak situation in plantations and farms which are mostly 4 years and above (Raymonda et al., 2011).

Control of these insect pests is mainly by use of insecticides applied through spraying, but sometimes application by fogging is necessary when the palms are tall. The nature of attack on palms by some of these insect species sometimes necessitate the use of systemic insecticide applied through spraying or trunk injection when the insect causing the damage is hidden within the internal structure of plants.

There are various insecticides approved by the Environmental Protection Agency (EPA) used to control these insect pests in Ghana. However, the need to search for new chemicals which are efficient, environmentally friendly and safe to human health and livestock nessacitate testing of these new chemicals which are introduced into Ghana before registration and permission for sale on the Ghanaian market.

INESPALM is a new insecticide which was manufactured by ifInesfly Corporation of Spain and is supposed to be used to control insect pests of palms especially coconut and oil palms.

Description and properties of INESPALM is as follows.

INESPALM
Insecticide and acaricide coating for plant protection use
DESCRIPTION
INESPALM is a formulation based on a new technology of microencapsulation of the active ingredients. The main benefit of the microencapsulation process is that it reduces the formulation toxicity for humans and improves the persistence of the insecticidal action. The active ingredient (deltamethrin) included within an Inesfly polymeric Microcapsule (IPM). Besides the active ingredient, INESFLY paints contain pigments and loads (and the IPM) in a volatile vehicle which is always water. The nature of the polymer and the load that covers it allows for the gradual and controlled release of the active ingredient.
The elevated persistence of INESPALM is due to the gradual release of the microencapsulated active ingredient. Since their release is slow and gradual the amount of insecticides in the environment is low, which means that toxicity is considerably reduced.

Moreover, formulate does not have any organic solvents which reduces the toxicity derived from them.
INESFLY has other properties not easily observed in other conventional pesticides: immediate, prolonged efficiency and an easy application.

COMPOSITION

Deltamethrin 0,5%, excipients q.s.p. 100%

PROPERTIES

The elevated persistence of INESPALM is due to the gradual release of the microencapsulated active ingredient. Since their release is slow and gradual the amount of insecticides in the environment is low, which means that toxicity is considerably reduced.
Moreover, formulate does not have any organic solvents which reduces the toxicity derived from them.
INESFLY has other properties not easily observed in other conventional pesticides:

- Immediate, prolonged efficiency and an easy application.
- Resistance to alkalinity.
- Adherence to different substrates.
- Resistance to bad weather.
- Resistance to water.
- Resistance to wet rub.
- Resistance to temperature and UV radiation.

USES

For arthropods control in agriculture and gardening, with insecticide and acaricide effect. Use in ornamental and crop for the control of all kinds of agricultural pests and ornamental plants. Specially indicated for the preventive control of the palm Weevil.
Edición revisada nº: 1
Fecha de emisión: 25/03/13
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TECHNICAL PROPIERTIES

Aspect: Matt and smooth. **Covering:** Excellent.
Whiteness: Extraordinary. **Yield:** 6-8 m2/kg .
Adhesion: Excellent. **Drying:** 30 minutes.
Colour: White or without colour.
Density: 1´1 □ 0´07. **Tools:** brush, roller, gun or spraying
Clearing: With water. equipment.
Solids in volume: 50 □ 3%. **Conservation:** During 2 year in original pack.

INESPALM was used to test against 4 major insect pests of oil palm at CSIR-Oil Palm Research Institute Entomology laboratory, nursery and field coconut palms. This report give details of investigations carried out.

2.0 Efficacy trial of INESPALM on the oil palm leaf miner *Coelaenomenodera lameensis* Berti and Mariau (Coleoptera: Chrysomelidae)

Plate 1. *C. lameensis* adult

Plate 2. Damage on palm caused by *C. lameensis*

2.1 Methodology

2.1.1 Laboratory procedure

Number of treatments: 5

T^0= distilled water

T^1= 25% INESPALM

T^2=50% INESPALM

T^3=75% INESPALM

T^4=100% INESPALM

Number of replications: 4

Number of adult leaf miners per petri dish= 10

Method of administering insecticide on insects: by dipping

Time schedules in minutes for taking data after insecticide treatments: (0, 10, 20, 30, 60, 120,180, 360, 720 and 1440) minutes.

Plate 3, 4 and 5 show the laboratory set up.

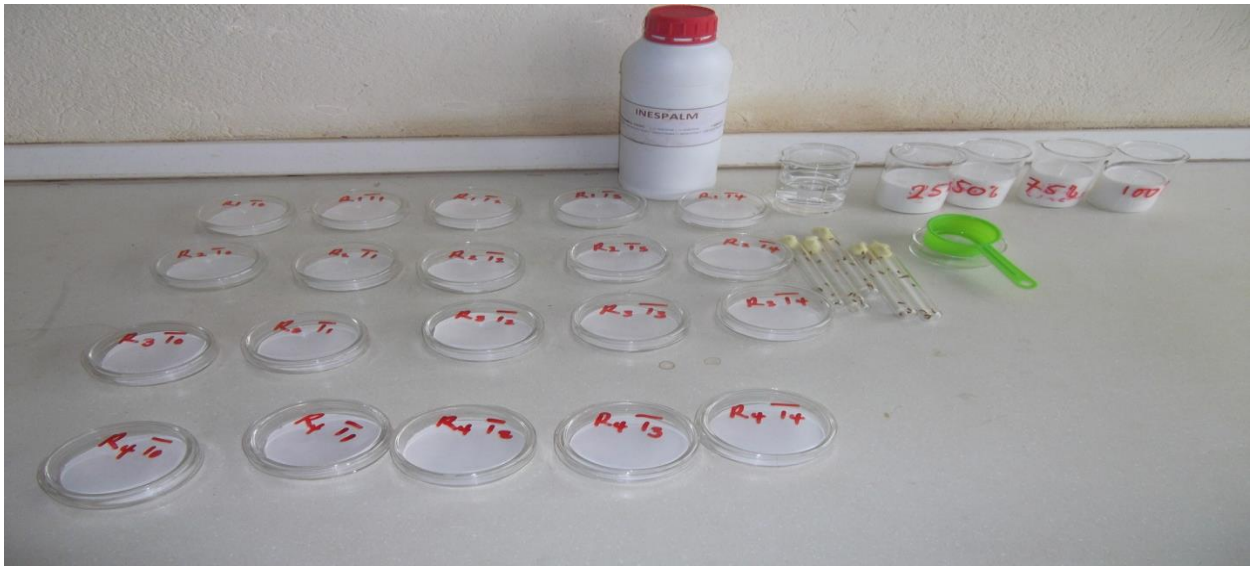

Plate 3. Experimental set up before introduction of treated insects

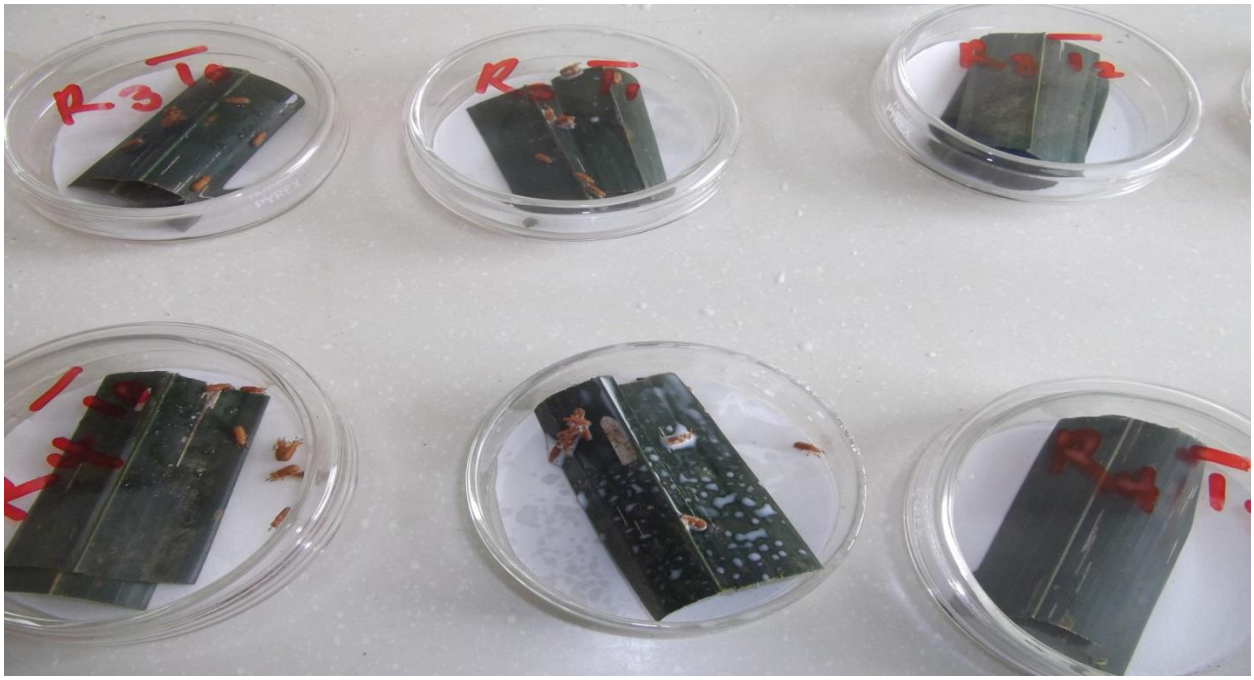

Plate 4. Treated *C. lameensis* in petri-dishes and pieces of leaflets to serve as food source for the insects

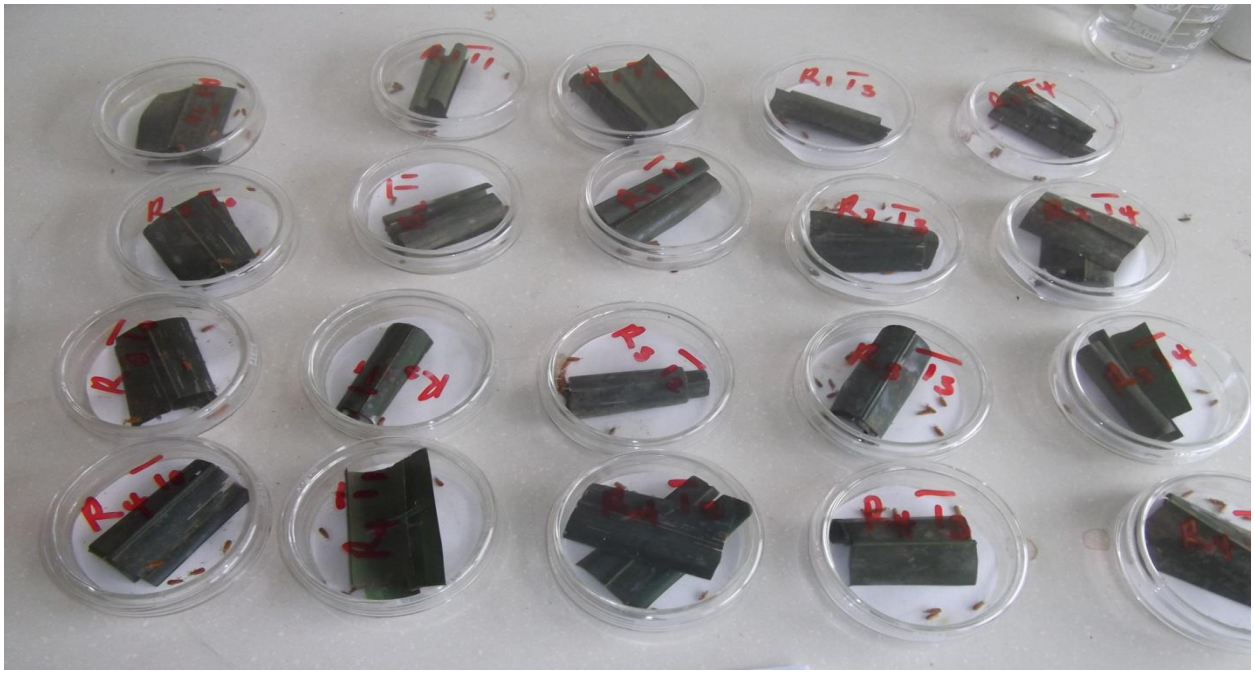

Plate 5. Treated *C. lameensis* in experimental set up

2.2 Result

INESPALM has strong knock down effect on the oil palm leaf miner *C. lameensis*. Most of the insects turned upside down after treatment and by 24 hours (1440 minutes) all the insects of all the treatment concentrations were dead except the control which registered no mortality. The laboratory result is shown in Figure 1.

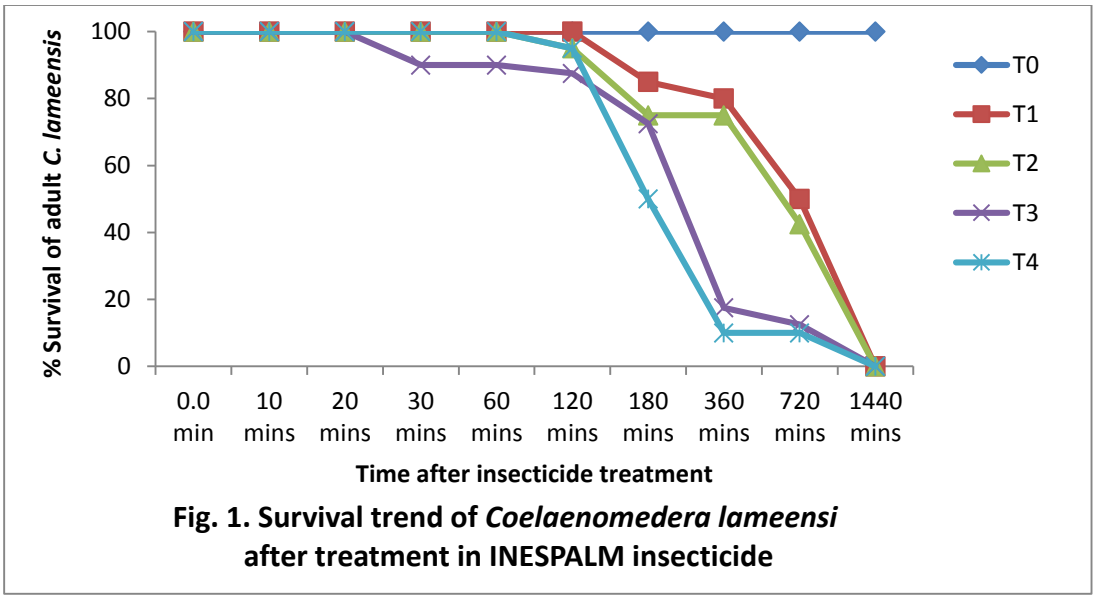

Fig. 1. Survival trend of *Coelaenomedera lameensi* after treatment in INESPALM insecticide

2.3 Conclusion

Laboratory testing showed INESPALM insecticide as being very effective against the adult leaf miner *C. lameensis* and can therefore be added to the arsenal of chemicals available in the country and approved by the Environmental Protection Agency to control the pest.

3.0 Efficacy trial of INESPALM on the oil palm weevil *Temnoschoita quadripustulata* Gyllenhall

Plate 6. *Temnoschoita quadripustulata* adult

Plate 7. Damage on oil palm seedling by pest

3.1 Methodology

3.1.1 Laboratory procedure

Number of treatments: 5

T^0= distilled water

T^1= 25% INESPALM

T^2=50% INESPALM

T^3=75% INESPALM

T^4=100% INESPALM

Number of replications: 4

Number of adult *T. quadripustulata* per petri dish= 10

Method of administering insecticide on insects: by dipping

Time schedules in minutes for taking data after insecticide treatments: (0, 10, 20, 30, 60, 120,180, 360, 720, 1440, 2880, 4320, 5760, 7200, 8640, and 10080) minutes.

Plates 8 and 9 show the laboratory set up.

Plate 8. Experimental set up and INESPALM insecticide

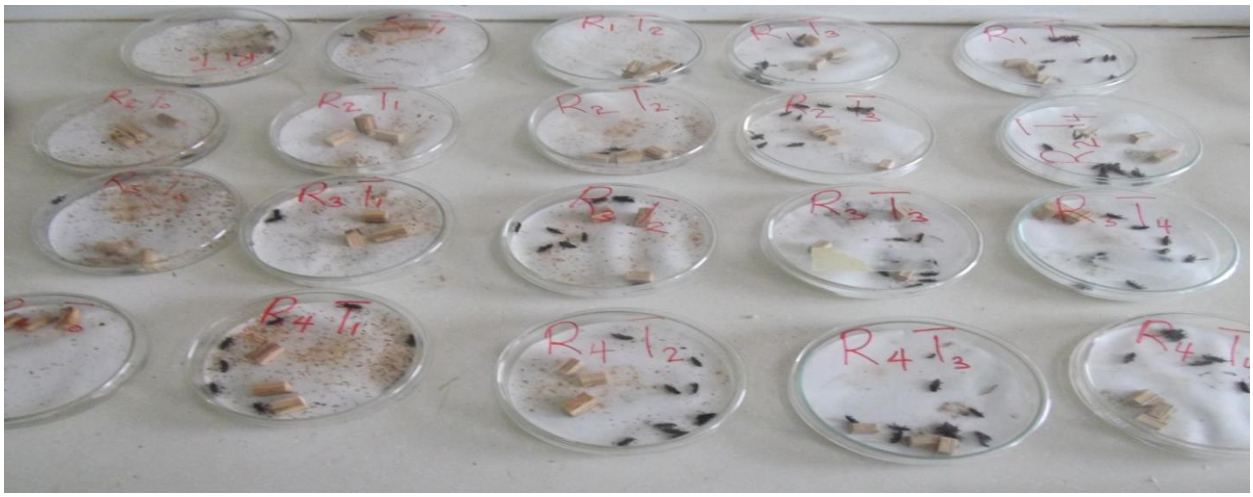

Plate 9. Experimental set up after chemical treatment

3.2 Result

INESPALM insecticide showed strong knock-down effect on adult oil palm weevil *T. quadripustulata* within 60 minutes after treatment in T^2 (50%), T^3 (75%) and T^4 (100%). However, some of the insects in treatments T^2 (50%) and T^3 (75%) recovered and started moving around from 120 minutes to 360 minutes. Some of the insect treated in T^4 also recovered over a period of 720 minutes. The effect of INESPALM insecticide on *T. quadripustulata* is shown in Figure 2.Treatment T^1 (25%) behaving similar to the control T^0 (distilled water) did not have any effect on the oil palm weevil, even over an extended period of 10 days. Treatment T^2 had less than 25% mortality on the insects after 10080 minutes. Mortality caused by treatments T^3 and T^4 were high after 4320 minutes. However, 100% mortality was not achieved after 10080 minutes and over an extended period of 23 days after the treatment.

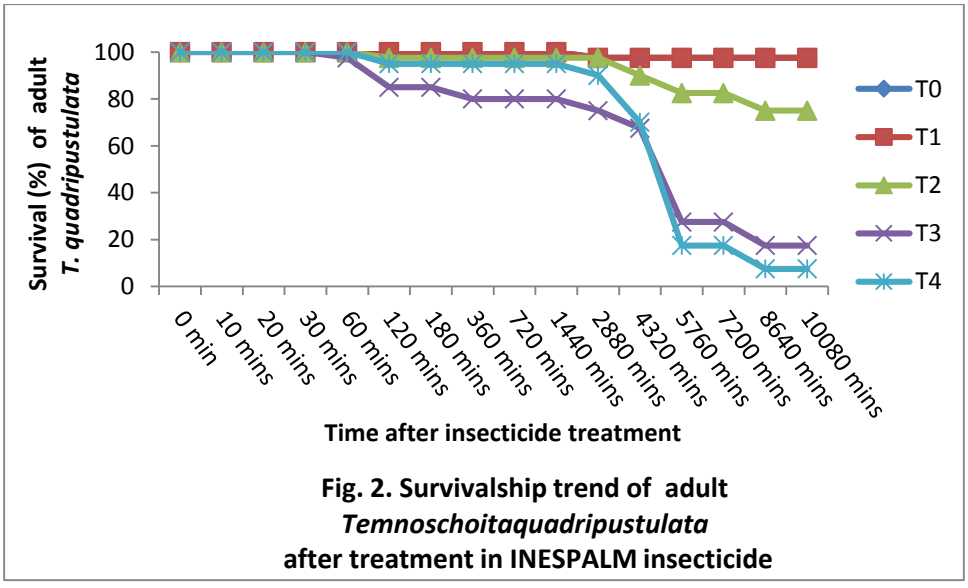

Fig. 2. Survivalship trend of adult *Temnoschoitaquadripustulata* after treatment in INESPALM insecticide

3.3 Conclusion

INESPALM insecticide has strong knock-down effect on the oil palm weevil *T. quadripustulata* .For control of oil palm weevil using INESPALM, the concentration of the chemical should not be less than 75%. INESPALM insecticide may be useful where monitoring of the insect species is necessary and killing is not the main objective.

4.0 Efficacy trial of INESPALM on the red striped oil palm weevil *Rhynchophorus phoenicis* larvae

Plate 10. *Rhynchophorus phoenicis* larvae

Plate 11. Damage on coconut caused by pest

Plate 12. Damage on coconut crown

Plate 13. Collection of adult,larvae, pupal cases of pest

4.1 Methodology

4.1.1 Laboratory procedure

Number of treatments: 5

T^0= distilled water

T^1= 25% INESPALM

T^2=50% INESPALM

T^3=75% INESPALM

T^4=100% INESPALM

Number of replications: 4

Number of *Rhynchophorus phoenicis* larvae per petri dish= 5

Method of administering insecticide on insects: by dipping

Time schedules in minutes for taking data after insecticide treatments: (0, 10, 20, 30, 60, 120,180, 360, 720, 1440, 2880, 4320, 5760, 7200, 8640, and 10080) minutes.

Plates 14, 15, 16, 17 and 18 show the laboratory set up.

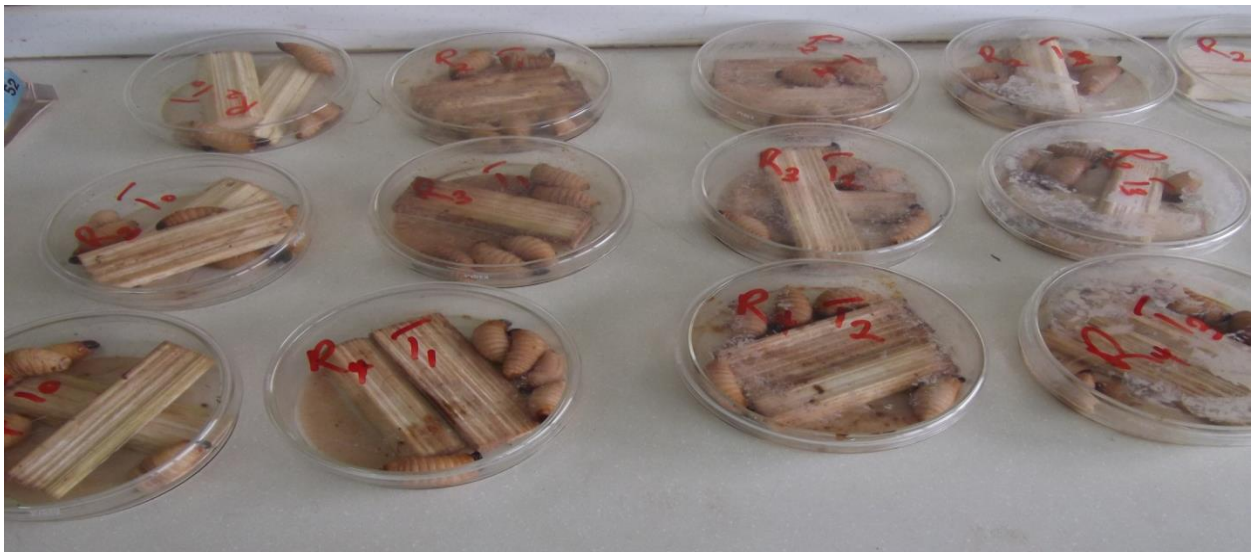

Plate 14. Experimental set up immediately after treatment in various concentration of INESPALM

4.2 Result

INESPALM insecticide causes larval *R. phoenicis* to be less mobile and stop feeding after treatment. The insecticide starts causing mortality after 720 minutes across all the concentrations except the control T^0. 100% mortality is caused by T^3 and T^4 within 8640 minutes. However, T^1 and T^2 concentrations are not able to cause 100% mortality even after10080 minutes and over an extended period of 20 days. They caused 70% and 80% mortality respectively. Dead larvae turn black in colour and shrivel. Surviving larval stop feeding or eat very little compared to the control where the larvae were very active, kept on eating their food i.e. rachis of frond, and separated the fibers in preparation to build a puparium case. Result of the laboratory testing is shown in Figure 3.

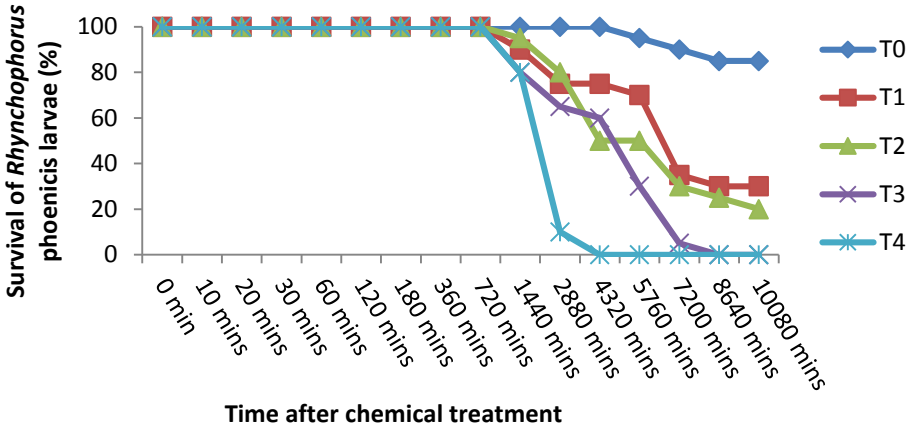

Fig. 3. Survival of *Rhynchophorus phoenicis* larvae after treatment in INESPALM insecticide

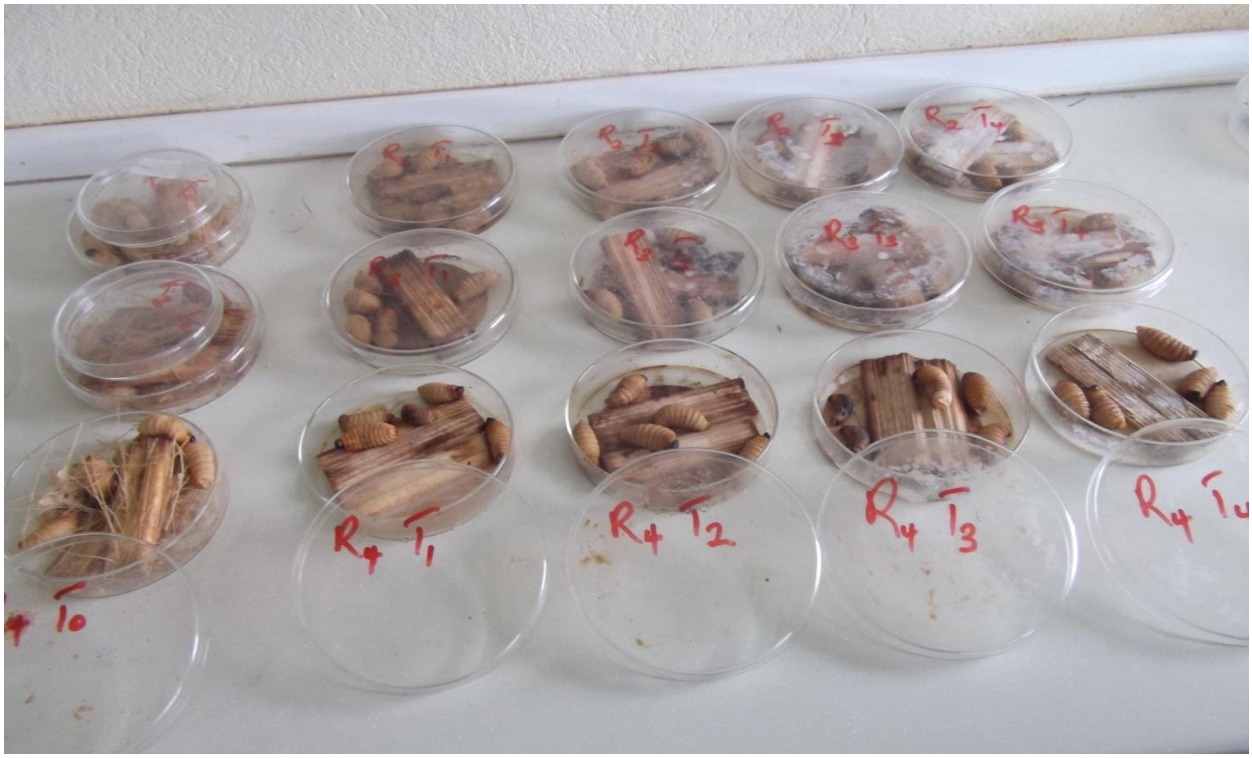

Plate 15. Experimental set up. 3 days after treatment

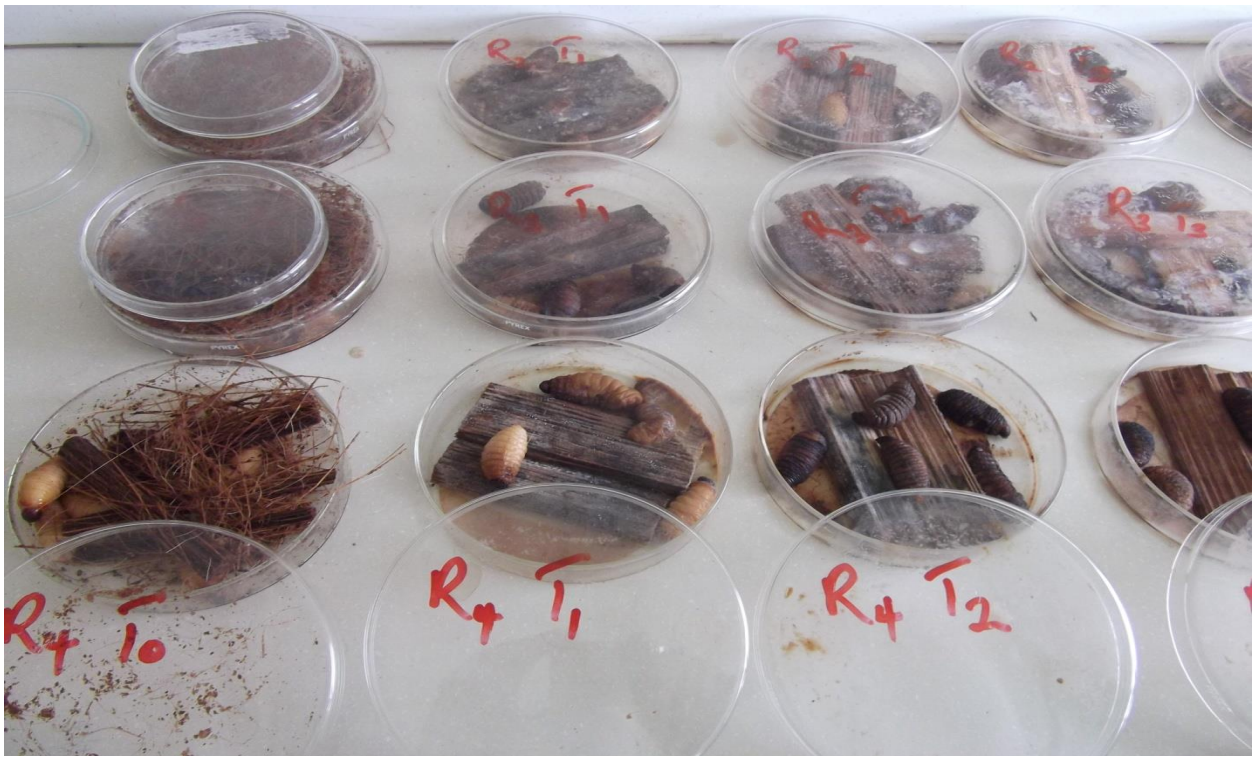

Plate 16. Experimental set up. 6 days after treatment

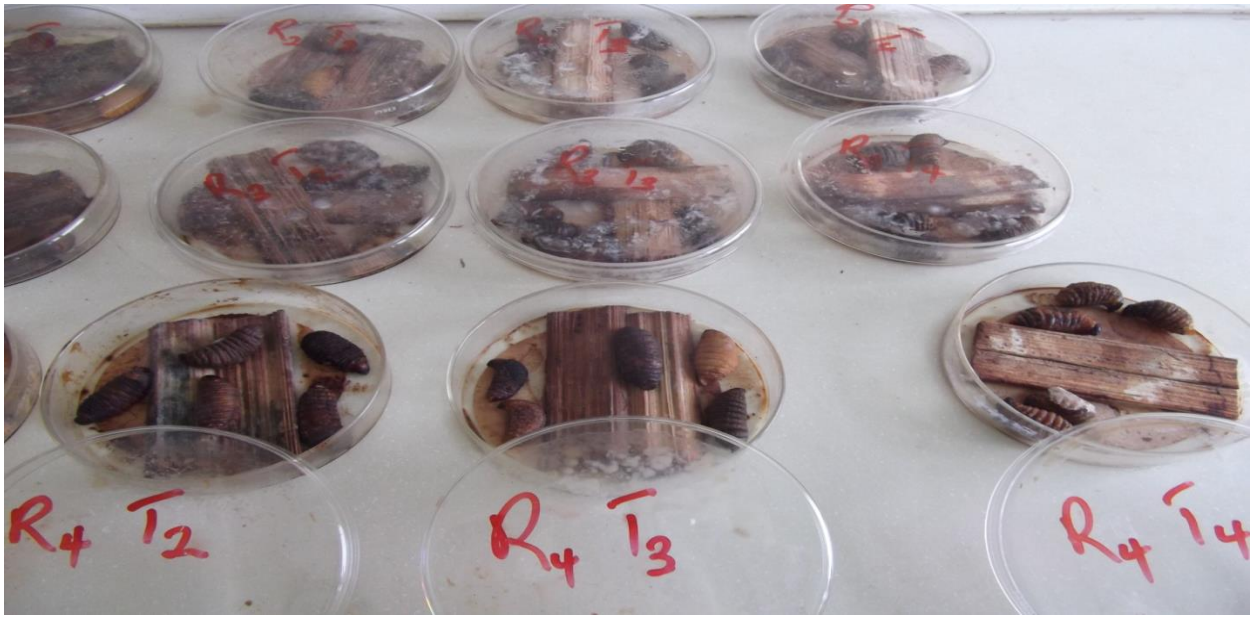

Plate 17. Experimental set up. 9 days after treatment

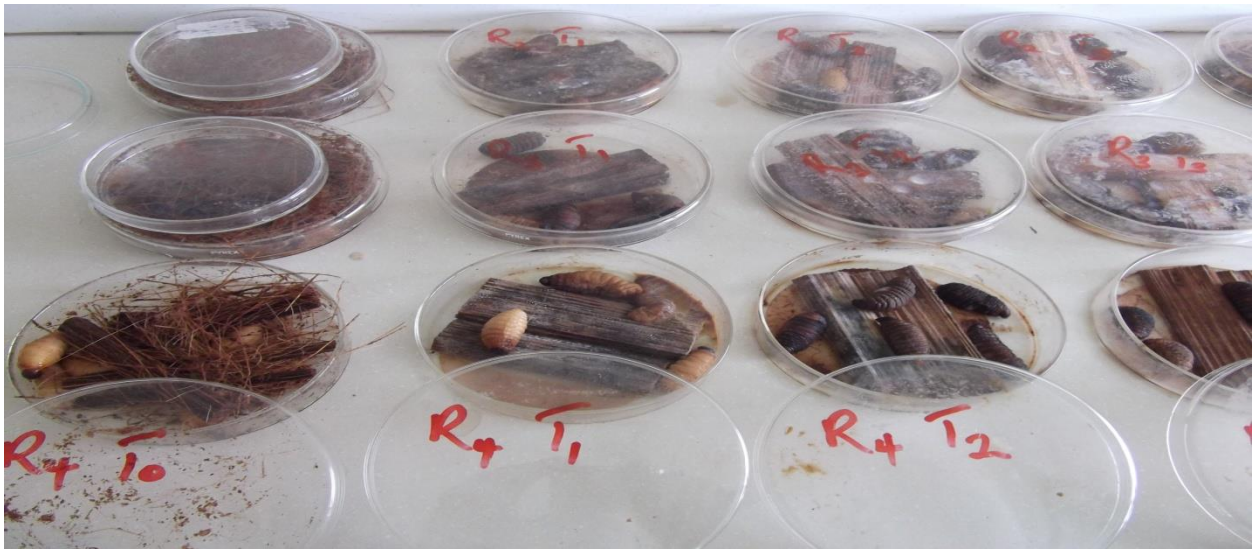

Plate 18**.** Experimental set up. 12 days after treatment

4.3 An unreplicated experiment to evaluate the effect of INESPALM on *R. phoenicis* larvae when they ingest INESPALM-treated coconut materials in the trunk.

A second unreplicated experiment to evaluate the effect of INESPALM on *R. phoenicis* larvae when they ingest INESPALM treated coconut materials in the trunk was set up. This was to have an idea as to what happen in treated coconut trunk when larvae *R. phoenicis* come into contact with treated material and ingest it. This experiment is important as larvae R. phoenicis cause a lot of damage by living and feeding on the internal structures of the trunk, eventually causing the crown to die and collapse.Though data on survival was taken over seven day period, this experiment was more observational using photographs. Rough graph on survival is shown in figure 4.

4.3.1 Laboratory procedure

Number of treatments: 5

T^0= distilled water

T^1= 25% INESPALM

T^2=50% INESPALM

T^3=75% INESPALM

T^4=100% INESPALM

Number of replications: 1

Number of *Rhynchophorus phoenicis* larvae per petri dish= 5

Method of administering insecticide on insects: Soaking pieces of frond in the various concentration of INESPALM for 12 hours and feeding the larvae in the petri-dishes over 7 day period and observing behavioral changes in the larvae.

4.3.2 Result

Plate 19. Day 1 of feeding *R. phoenicis* larvae with INESPALM treated frond rachis.

Plate 20. Day 2 after feeding *R. phoenicis* larvae with INESPALM treated frond rachis.

Plate 21. Day 3 after feeding *R. phoenicis* with INESPALM treated frond rachis.

Plate 22. Day 7 after feeding *R. phoenicis* with INESPALM treated frond rachis.

Larvae in the control T^0 feeding on untreated frond were busy were preparing pupal case while larvae on treated fronds T1-T4 had stopped feeding from day 1-7 turned black before death.

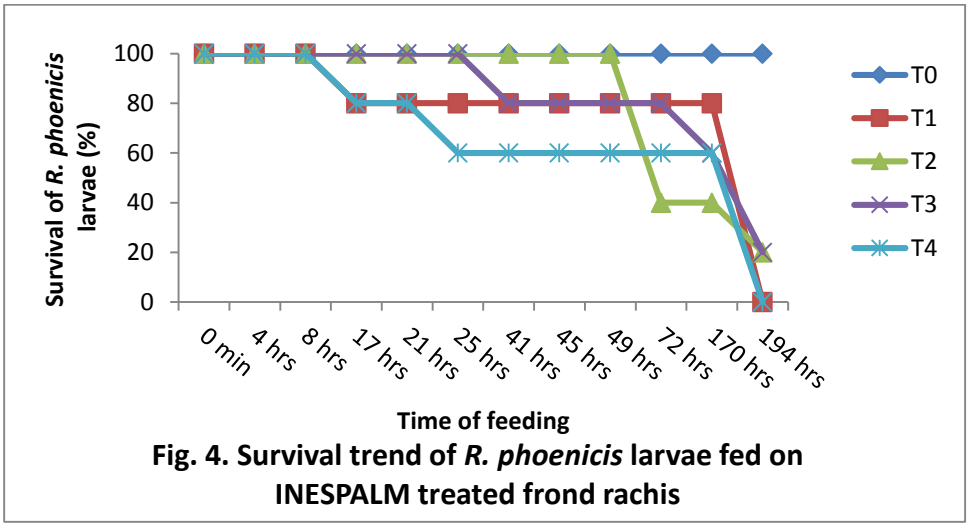

Fig. 4. Survival trend of *R. phoenicis* larvae fed on INESPALM treated frond rachis

4.4 Conclusion

INESPALM insecticide causes *R. phoenicis* larvae to stop feeding or eat very little. They become less mobile but the insecticide takes a long time to cause mortaliy by contact. Treated larvae develop soft body, do not transform into other larval stages, turn brown to black and gradually shrivel before dying. The insecticide causes rapid mortality if the insect ingest the chemical. Since the larvae are hidden within the crown of the palm and trunk, the insecticide should be used as systemic against the larvae on palms and the concentration should not be less than 75% for rapid kill.

5.0 Efficacy trial of INESPALM on the red striped oil palm weevil *Rhynchophorus phoenicis* adults

Plate 23. *Rhynchophorus phoenicis* adults

5.1 Methodology

5.1.1 Laboratory procedure

Number of treatments: 5

T^0= distilled water

T^1= 25% INESPALM

T^2=50% INESPALM

T^3=75% INESPALM

T^4=100% INESPALM

Number of replications: 4

Number of adult *Rhynchophorus phoenicis* per petri dish= 4

Method of administering insecticide on insects: by dipping

Time schedules in minutes for taking data after insecticide treatments: (0, 10, 20, 30, 60, 120,180, 360, 720, 1440, 2880, 4320, 5760, 7200, 8640, and 10080) minutes.

Plates 24, 25, 26 and 27 show the laboratory set up.

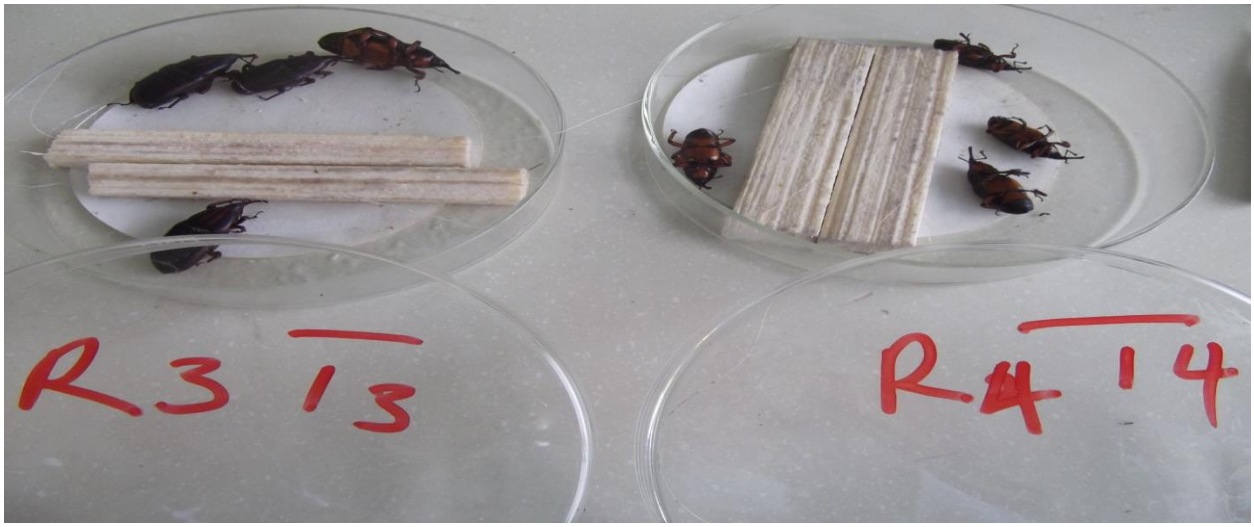

Plate 24. Some of the experimental set up immediately after dipping insects in INESPALM

5.2 Result

Figure 5 show the time schedule result after treating *R. phoenicis* adults in INESPALM insecticide. The immediate effect of INESPALM insecticide on adult *R. phoenicis* is the knocking down of the insects. All the insects treated in the various concentrations except the control turned up-side down after few minutes of movement. The insects treated in the highest concentration start dying after 120 minutes. All the insects treated in T^3 and T^4 died within 24 hours (2880 minutes).

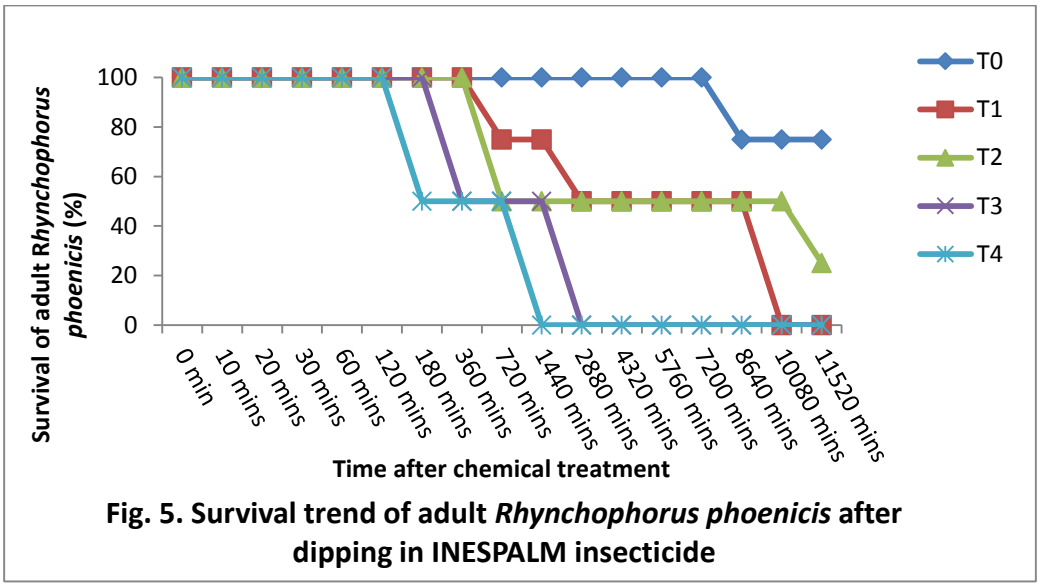

Fig. 5. Survival trend of adult *Rhynchophorus phoenicis* after dipping in INESPALM insecticide

Plates 25, 26, 27. Some of the experimental set up result.

5.3 Conclusion

INESPALM insecticide is effective against adult R. phoenicis. It causes rapid knock-down of the insects. However, the recommended application rate should not be less than 50% concentration. The lower rate will cause knock-down alright and the insects turned upside down but it takes a long time for the insect to die.

5.4 Efficacy trial of INESPALM on the red striped oil palm weevil *Rhynchophorus phoenicis* on infested coconut on the field (KC2)

Plate 28. Damaged coconut crown **Plate 29. Larvae *R. phoenicis* in coconut trunk**

5.4.1 Experimental procedure

Thirty coconut palm trees (classified as seed trees) were selected from the germplasm field (KC2) where *Rhynchophorus phoenicis* attack on palms was serious. These coconut palm trees are used mainly for the production of coconut seedlings for establishment of new fields and for sale to the general public.Ten of the selected palms which were under attack were injected with 10 mls of undiluted INESPALM insecticide on September, 19, 2013. The remaining 20 palms were also injected with 20 mls of INESPALM insecticide in September, 20, 2013. The palms were observed weekly over 56 days to see whether the palms symptom of attack will progress or the palm will recover.

Plate 30. Distress coconut

Plate 31. Drilling a hole for trunk injection

Plate 32. Preparing INESPALM in syringe

Plate 33.Introducing INESPALM into coconut trunk

5.5 Result

All the coconut trees showing symptoms of attack which were injected with 10mls and 20mls of INESPALM insecticide showed strong signs of recovery 56 days (almost 2 months) after treatment except two trees which were showing advanced symptoms of attack. These two trees could not recover as the growing point had been destroyed probably before the injection or due to delay in translocation of the chemical to the growing point before destruction by the larvae. Trees treated with 20mls showed quick and strong recovery than those treated with 10mls. Sap oozing from the trunks of the trees had stopped and noises of larvae chewing the internal materials of the trunk which were heard when the ears were placed close to attacked coconut trunks could not be heard any longer. The central spears of distress trees had started growing normally. Surprisingly, *Oryctes monoceros* adults and larvae which were also common on coconut palms under attack by the *R.phoenicis* were no longer seen on the treated trees when the crown of the trees were examined using ladder or when the heavily infested treated trees which were almost dead were felled and cut into pieces for assessment. Plates 34-42 show some of the treated trees the on the field.

Plate 34. Recovered tree

Plate 35.Treated dead tree

Plate 36.Recovered tree

Plate 37. Recovered tree

Plate 38. Treated distress tree

Plate 39.Pupal cases in frond of distress tree

Plate 40. Larvae extracted from case

Plate 41.Treated tree in distress

Plate 42. Normal growing spear

5.6 Conclusion

INESPALM insecticide is very effective against *R. phoenicis* adults and larvae attacking coconut palms. The application of the insecticide should be through trunk injection about 20cm below the crown in early detection. The recommended rate should be 20 mls of undiluted insecticide. The insecticide is also effective against *O. monoceros* attacking the palms.

6.0 Efficacy trial of INESPALM on *Oryctes monoceros*

Plates 43. Adult *Oryctes monoceros*

Plate 44.Damage on oil palm caused by ***O. monoceros***

6.1 Methodology

6.1.1 Laboratory bio-assay

Number of treatments: 5

T^0= distilled water

T^1= 25% INESPALM

T^2=50% INESPALM

T^3=75% INESPALM

T^4=100% INESPALM

Number of replications: 4

Number of adult *Oryctes monoceros* per petri dish= 5

Method of administering insecticide on insects: by dipping

Time schedules in minutes for taking data after insecticide treatments: (0, 10, 20, 30, 60, 120,180, 360, 720, 1440, 2880, 4320, 5760, 7200, 8640, and 10080) minutes.

Plates 45, 46, 47 and 48 show the laboratory set up.

Plate 45. Laboratory set up

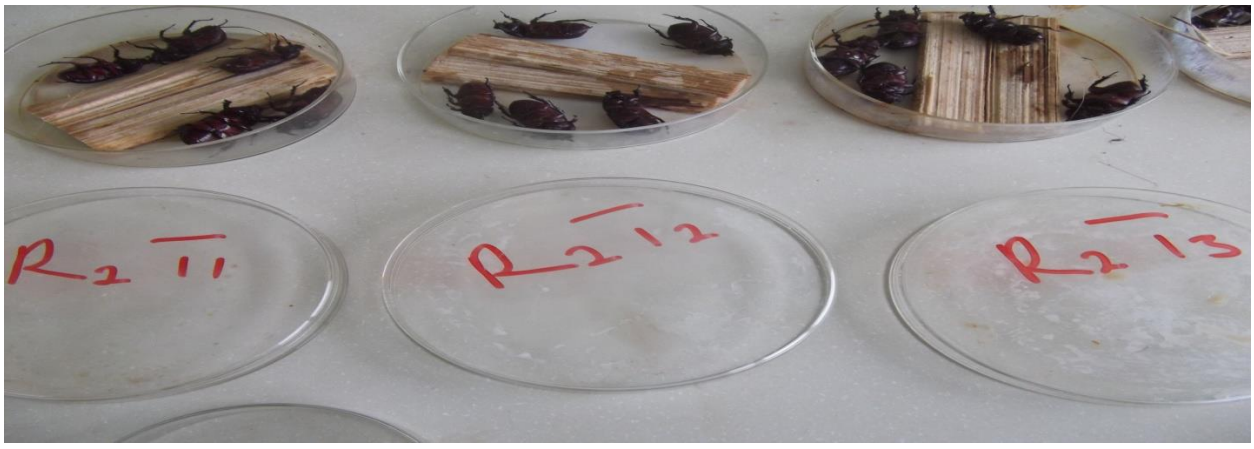

Plate 46.

Plate 47.

6.2 Result

O. monoceros adults cannot tolerate INESPALM insecticide by contact. All the insects treated with the various concentration of INESPALM insecticide except the control turn upside down immediately after contact. Movement of the insects is seen mainly of the legs until death within 24 hours.

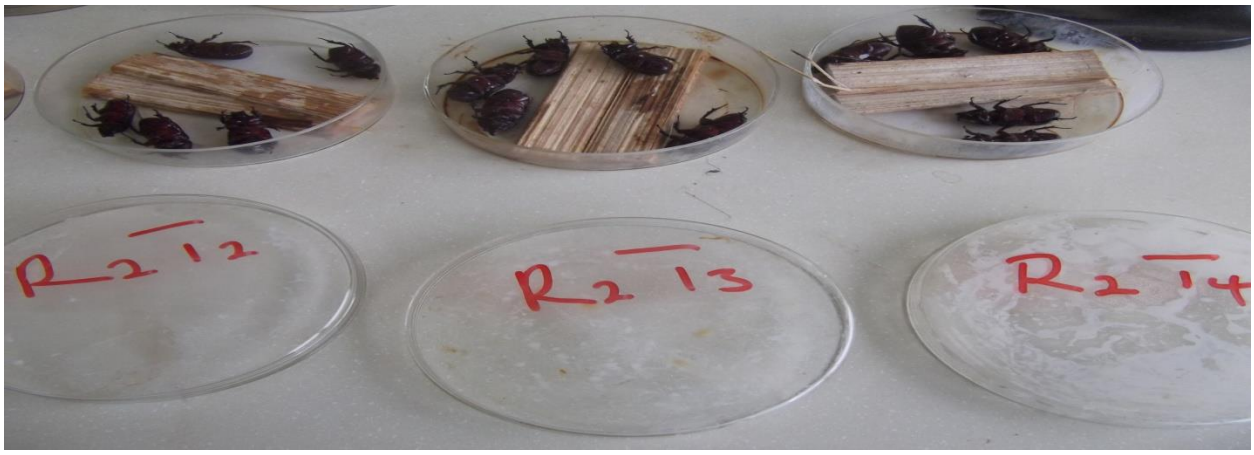

Plate 48.

Figure 6 show the survival trend of the pest after dipping.

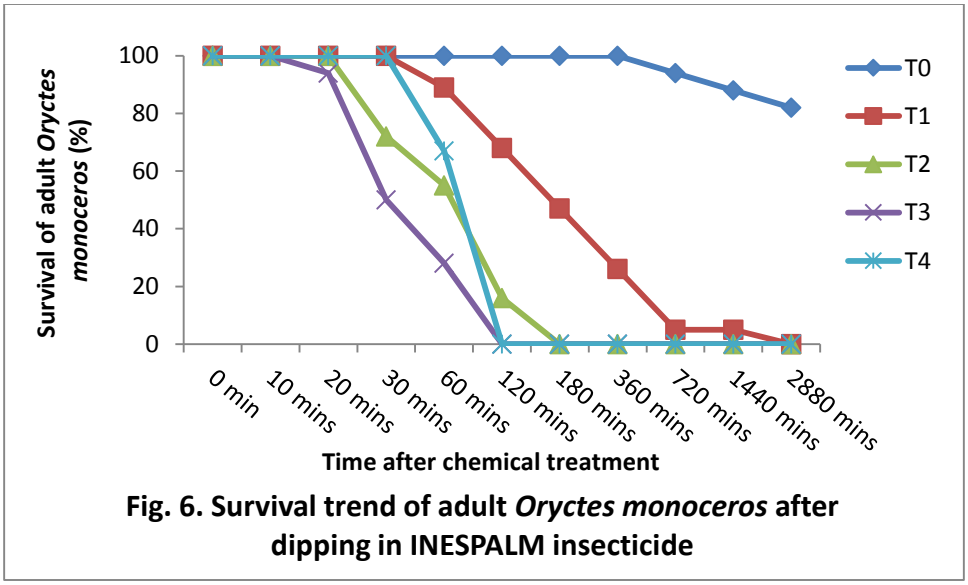

Fig. 6. Survival trend of adult *Oryctes monoceros* after dipping in INESPALM insecticide

6.3 Conclusion

Laboratory result show that *O. monoceros* is very susceptible to INESPALM insecticide on contact and will die within 24 hours. INESPALM insecticide is highly recommended for control of *O. monoceros.*

6.4 Field experiment to control *O. monoceros* on nursery coconut palms

This field experiment was carried out in two phases on 1½-year nursery palms.

1. Spraying of the insecticide directly on the young seedlings.
2. Stuffing the leaf bases and axil of the palm seedlings with sawdust and spraying the insecticide mainly on the sawdust on the leaf axil. This is to retain the chemical on the axil for a long time and avoid rainfall washing the chemical after one rainfall.

The 1st phase was observed and lasted for 18 days followed by the sawdust treatment which also was observed for 18 days. Plates 49 and 50 show attack of *O. monoceros* on some of the nursery seedlings.

Plate 49.Damage on coconut seedling

Plate 50. *O. monoceros* adult from coconut seedling

6.4.1 Experimental layout, Phase 1 (Manual spraying application)

Number of treatment: 5

T^0= Control= No treatment

T^1= 100 ml INESPALM / 15 Lt of water

T^2=200 ml INESPALM / 15 Lt of water

T^3=300 ml INESPALM / 15 Lt of water

T^4=400 ml INESPALM / 15 Lt of water

Number of replication=4

Number of palms per treatment replication= 30 palms

Total number of palm used for the experiment= 600 palms

Mode of application of insecticide: By spraying using manual sprayer (Swiss MEX)

Data collection

1. Number of *O. monoceros* attacking palms per day in treatments over 18 days
2. Number of palms attacked by *O. monoceros* per day in treatments over 18 days

Duration of experiment: 18 days

Phase 2

Saw-dust was stuffed to the leaf axils of all the seedlings INESPALM insecticide was sprayed on the sawdust on the all the leaf axils of the seedlings following the same treatments as the 1st phase. Data collection was same as the 1st phase for duration of 18 days.

Plate 51. Nursery coconut seedlings used for the experiment.

Plate 52-55 show the experimental layout. Different colour rubber strips show boundary of different treatments

Plate 52.

Plate 53.

Plate 54.

Plate 55.

6.4.2 Result (Phase 1)

Figure 7 show result of the 1st phase of the experiment. Although the palm seedlings were attacked, the number of attacked palms reduced significantly compared with the period before the application of the INESPALM insecticide. The attack on the palms could be described as random. T4 was least attacked and attacked occurred on the 13th day after application of the insecticide by which time rainfall might was most of the chemical reducing its potency. Some palms in the various treatments except treatment 4 were attacked before the 13th day. Treatment T3 palms suffered the highest attack on the 16th day and the frequency of attack from the 13th day show reduced potency of the chemical probably due to dilution by rainfall or wash away by rainfall run-off.

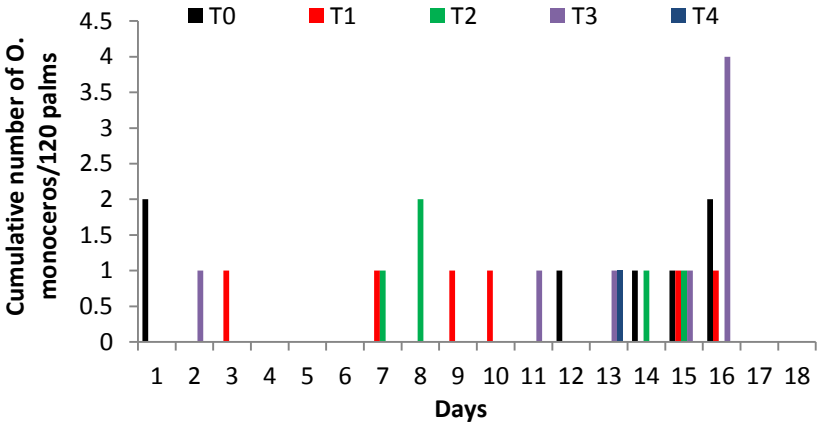

Fig. 7. Trends of attack of *O. monoceros* on nursery palm seedlings sprayed with INESPALM insecticide

6.4.3 Result (phase 2)

Plate 56. Nursery coconut stuffed with saw-dust before application of INESPALM insecticide on the sawdust in the axil.

Figure 8 show result of phase 2.

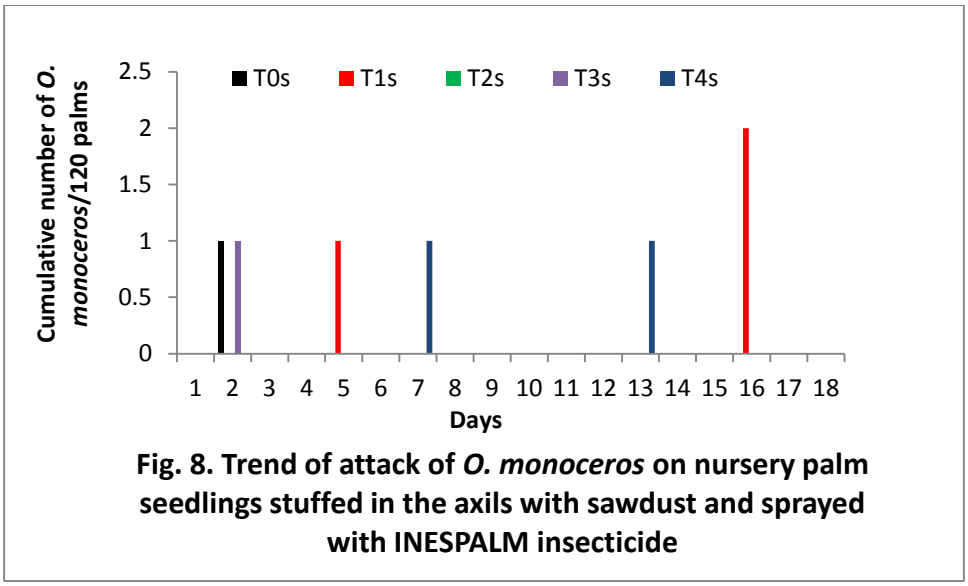

Fig. 8. Trend of attack of *O. monoceros* on nursery palm seedlings stuffed in the axils with sawdust and sprayed with INESPALM insecticide

Figure 8 show reduced attack by *O. monoceros* on the palm seedlings after application of INESPALM on the palm seedlings through sawdust. Attack on palms again could be described as random. Treatment 2 was not attacked. Treatment T1 suffered the highest attack. It is significant to note that *O. monoceros* in this attack avoided attacking the palms through the axils and attacked the palms through the base where the palms are in contact with the soil in the pot.

6.5 Conclusion

INESPALM insecticide is effective in controlling *O. monoceros* on nursery palms. The application should be through saw-dust treatment for reduced attack and longer effect. The recommended dosage should be less than 200 mls INESPALM per 15 liter of water.