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Efficacy of Palm Tree Weevil Killer for Control of Adult Weevils in Nigeria

T. I. Aneni*, **V. C. Adaigbe**, **O. O. Adeoye**

Entomology Division, Nigerian Institute for Oil Palm Research, Benin, P.M.B. 1030, Nigeria.

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Corresponding author: T. I. Aneni, Entomology Division, Nigerian Institute for Oil Palm Research, Benin, P.M.B. 1030, Nigeria.

Abstract

Insect pests pose a serious threat to palm plantations that need knowledge and tools for their detection, control, and management. The control of insect pests in the palm industry has mainly relied on chemical pesticides. This has proved unsustainable. The adult weevils, *Oryctes monoceros* and *Rhynchophorus phoenicis* are currently major insect pests that attack coconut palm plantations in Nigeria. The efficacy of the Palm Tree Weevil Killer (PTWK) root treatment method was evaluated for its bio-insecticidal control on *Oryctes monoceros* and *Rhynchophorus phoenicis* adult forms at NIFOR coconut palm plantation, Nigeria. The experimental plot was 2.3Ha compared with a similar untreated plot. Observations were made for 6 weeks after treatment, for dead adult weevil populations. Data were subjected to one-way analysis of variance, independent sample T-test, and testing for significant difference in the effect of insecticidal treatment on adult weevil populations. Results indicate that exposure to the insecticide at 20 liters of water added to 33.33ml of PTWK super concentrate induced high mortality against the weevils. The highest population of dead weevil adults was observed 4 weeks after treatment. Total percentage mortality of weevil adults was 34.4% (treatment) and 15.38% (control) at week 4, indicating effective control. The use of the plant-based palm tree weevil killer base contributed positively to the control of adult weevils in the trial plot. The biodegradable palm tree weevil killer base is recommended to the palm industry as a management technology for weevil control and its potential for increasing productivity in palm plantations.

Keywords

Insect pests; Coconut palm; Palm tree weevil killer; Biodegradable; Root treatment

1. Introduction

Research on botanical control of *Rhynchophorus phoenicis* (African palm weevil) has expanded in recent years, though direct field evaluations on coconut remain limited. Much of the evidence is drawn from laboratory assays and studies of related *Rhynchophorus* species. Hoddle et al. emphasized that plant secondary metabolites such as neem extracts and essential oils display toxic, repellent, and anti-feedant properties, which could be integrated into management frameworks for palm weevils [1]. Similarly, Siddiqui reviewed the biology and control of *R. phoenicis*, noting that botanicals are increasingly promoted as eco-friendly alternatives to synthetic chemicals in tropical smallholder contexts [2]. These claims are supported by multiple empirical studies.. Gabr et al. demonstrated that neem oil extract significantly increased larval mortality of palm weevils and altered key biochemical defense enzymes, suggesting its suitability for targeting early instars. Additional trials confirmed that azadirachtin and neem formulations can disrupt larval growth and adult emergence in *Rhynchophorus* spp. [3]. Mohamed further showed that defense enzyme expression peaks at specific larval stages of red palm weevil, indicating that the timing of botanical application is critical for effective control [4]. Beyond neem, other botanicals have been explored. Essential oils from plants such as eucalyptus and citrus exhibited fumigant and repellent effects against *Rhynchophorus* spp., though these findings remain largely at laboratory scale and require validation under coconut field conditions [4]. Integration into integrated pest management (IPM) has been proposed. For example, a study on Okomu plantations highlighted that combining botanicals with cultural practices, pheromone trapping, and sanitation achieved more sustainable suppression of *R. phoenicis* than chemical insecticides alone [5]. Overall, evidence suggests plant-based insecticides, particularly neem derivatives and essential oils, hold potential for managing *R. phoenicis* in coconut. However, further research is needed to establish species-specific field efficacy, optimal dosages, and economic feasibility for smallholder farmers [1, 2].

Oryctes monoceros (Olivier, 1789), commonly known as the rhinoceros beetle, is one of the most dangerous pests in young coconut and oil palm plantings throughout West Africa, causing up to 40% damage in Tropical Africa [6]. *Oryctes monoceros* has been recorded as a major pest of palms in Nigeria, Ghana, and other parts of West Africa [7-10]. Damages caused by *Oryctes* species pests include deformation, defoliation, and destruction of parenchymatous tissues of leaves, inflorescence, and stems by weevils and adults [11]. 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 dries up and can be easily pulled off. Often, an attack by *O. monoceros* predisposes the palm to a secondary attack by *Rhynchophorus phoenicis*. *O. monoceros* is highly aggressive toward young plants younger than 5 years old [12, 13]. The damage inflicted by this pest is characterized by the excavation of galleries on young leaves. Its attack either delays the young plants' development or causes some losses greater than 30 % [14, 15].

Oryctes monoceros (Coleoptera: Dynastinae) are insects with a long adult lifespan of at least three months [16, 17, 7]. Females lay eggs in rotting stems, where the larvae develop, then build a fibrous cocoon in which pupation takes place. The behaviour of *Oryctes rhinoceros* (Coleoptera, Dynastidae) adults was studied by [17] and [18]. These authors found that virgin females were sexually immature on emergence and moved to palms to feed. Adults had long feeding periods on palms, usually remaining alone there for up to ten days in a gallery, and moving occasionally to the reproduction (larval breeding) sites to mate and lay eggs. Similar behaviour was found in *O. monoceros* [19]. These beetles breed in decaying wood, particularly decaying palm trunks, and in manure and compost heaps. They lay their eggs in the decaying vegetable matter, often boring well inside to do so. The eggs, white and the size of mustard seeds, hatch in 7 to 9 days. The larvae take between one hundred and two hundred days to reach maturity according to temperature and availability of food, and the pupal stage lasts from 14 to 21 days. Damage is caused by the adult beetles since they bore into the growing tip of the palm; in some cases, this kills the palm, particularly if it is a young one, but generally it causes a considerable reduction in leaf area and distortion of the palm [20]. Only adults of this pest cause damage to coconut and oil palms [21]. The larval instars are found in rotting plant matter, which forms the larval site. In the daytime, adults can be found in feeding galleries made in coconut or oil palms, where they remain for 2 to 11 days. They then leave the feeding galleries via the same entrance hole and return to the larval sites to mate. They are nocturnal and start flying at 6:30 pm, as night falls, until around 9:30 pm. They fly towards the leaf crown of young coconut palms a few months after planting, and prefer to land on the youngest fronds. They then brace themselves against the frond petiole and mine a gallery down to the tender tissues. The spear of an attacked plant is often cut at the base. Adults use their mandibles to shear, moving their head up and down, rather than chewing; their horns and the spines on the tibias of their powerful front legs help in the perforation process [22]. Adults can mine galleries from a few dozen centimeters long in young coconut palms to more than a meter (46 cm on average) in older coconut palms [19]. Unlike *Oryctes rhinoceros*, the species *monoceros* is not gregarious. Usually, a single adult is found on a young coconut palm. It is very rare to find a couple of *Oryctes monoceros* in the same gallery. The first attack usually occurs on coconut palms of a certain height. The smallest palms are very often overlooked by adults. Then, attacks seem to be more directed at coconut palms that have already been attacked at least once [23]. According to [24], the physical effect of the attack makes the tissues of the leaf crown more attractive to adults. An adult may remain in its feeding gallery for 2 to 11 days before leaving by the entrance hole. Mating usually takes place in larval sites. Flight is generally limited to a few hundred meters, though that distance can reach 12 km under certain conditions. Palm tree weevil, among the palm pests, belongs to the order Coleoptera, characterized by having forewings that are thickened and hardened into elytra, which are used to protect the delicate folded hind wings. They range in size from minute to gigantic insects and belong to different families. Most weevils have a well-developed downward curved snout, the antennae of most species are elbowed and clubbed, and the first segment often fits into a groove in the side of the snout. Research in Nigeria has highlighted that decomposing palm trunks and heaps of farmyard manure are the most productive breeding sites for O. monoceros, emphasizing the need for sanitation (clearing and proper disposal of rotting organic matter) as a fundamental cultural control practice [25]. Given the demand for safer, eco-friendly control options, several studies have evaluated plant extracts. Neem (Azadirachta indica) and garlic (Allium sativum) extracts have shown significant repellent and toxic effects against *R. phoenicis* larvae in bioassays, offering potential for development into biopesticides [26].

Many methods have been adopted to control palm pests, which, among others, include cultural control, mainly pesticide (chemicals), which, of course, have adverse effects on the environment and could bio-accumulate in human tissue [27]. It is against this background that a safer plant-derived product formulation could be used due to its biodegradable properties, and PTWK belongs to this type of formulation based on its components.

The objective of the study was to evaluate the efficacy of the plant-based Palm Tree Weevil Killer (PTWK) base for the control of adults of the palm weevils, *Oryctes monoceros* and *Rhynchophorus phoenicis* of the Coconut palm in NIFOR, Nigeria.

2. Materials and Methods

2.1 Study Site

The study was conducted in field 18a, consisting of 15 lines (2.3 Ha) of progeny coconut palm varieties (Dwarf green, Dwarf yellow, Dwarf orange, Tall, and Hybrid) made up of a total of 345 palms at the Nigerian Institute for Oil Palm Research, Edo State, Nigeria. The field was established in 2016 with a planting density of 150 palms per hectare, arranged in an 8-meter triangular spacing. Field 18b, consisting of 15 lines (2.3 Ha), was the control where no treatment application was made.

2.2 Insecticide Evaluation

Palm tree weevil killer (PTWK) was obtained from Green Earth Technologies Global, New Jersey, USA. It was evaluated for the control of adult weevils of the Coconut palm.

Table 1. Composition Information

S/N	Component	Amount	Active/Inert
1	Clove oil	14%	Active
2	Thyme	14%	Active
3	Sodium Laureth Sulphate	20%	Active
4	Filtered water	20%	Inert
5	Palm oil	12%	Inert
6	Coconut soap	20%	Inert

2.3 Experimental Design

The study area was selected based on a history of infestation that indicates palm weevil (*Oryctes monoceros* and *Rhynchophorus phoenicis*) attack on the palms. A complete randomized design (CRD) was utilized. The total experimental plot was 2.3Ha. Weekly observations were made for 4 weeks. Physical phytosanitary inspections and counts of dead or immobile *R. phoenicis* individuals were conducted to monitor mortality. Since PTWK is systemic and acts via the roots, a second treatment was made after 2 weeks of the first treatment to ensure effective action on any residual population. It was assumed that immigration and emigration of the weevils were minimized, and there were no recruitments from births.

2.3.1 Pre-application Assessment

A treatment pre-application assessment of the study site was conducted for the identification and counting of the observed insect population. Damage assessment was conducted by traversing the entire length of each planted line and evaluating damage on randomly selected coconut palms.

Figure 1. Infested Coconut palm.

2.3.2 Treatment

PTWK was applied to 3 infested coconut palms per line (15 lines total, 45 palms), all of which were tagged. The study followed the palm tree weevil killer (PTWK) root treatment method procedures [28].

(1) A basin was made around the palm to concentrate the product in the roots. A circular trench was dug around each tree, 60 cm from the trunk, with a diameter of approximately 7 cm and a depth of 30 cm.

(2) 20 liters of water were added to 33.33ml of PTWK super concentrate.

(3) Ten liters of the diluted product were poured into each tree basin, which was the required volume for the first treatment.

(4) After two weeks, steps 2 and 3 were repeated.

Figure 2. Palm treatment basin.

2.3.3 Post-application Assessment

Upon the application of the weevil killer treatment, weekly observations were done for 4 weeks on both treatment and control sites. Additionally, physical phytosanitary inspections and counts of dead or immobile pests were conducted to monitor mortality. A second treatment was made after 2 weeks to ensure effective action on any residual population.

2.4 Statistical Analysis

Data were analyzed using one-way analysis of variance to test for significant differences between control and experimental means and within various treatments.

3. Results and Discussion

Using the root treatment method, the PTWK also increased tree growth and strengthened the trees by breaking down salts in the soil, thereby enhancing the trees' nutritional intake [28]. Analysis of Variance of the Population of Adult Weevils in the Treatment Plot is presented in Table 2. This table (Table 2) shows differences in the effects of PTWK at the various application times.

Table 2. Analysis of Variance of the Population of Adult Weevils in the Treatment Plot

Time of Application	Adult Weevils
Pre-Application	0.52 ± 0.551
1 Week after	0.42 ± 0.221
2 Weeks after	0.51 ± 0.311
3 Weeks after	0.47 ± 0.378
4 Weeks after	0.36 ± 0.489
5 Weeks after	0.31 ± 0.022
6 Weeks after	0.24 ± 0.000
Total No. of Adults	2.62 ± 1.973
Significance	0.164

Adult significance (P = 0.005) indicates that there are differences in the effect of the insecticidal treatment on the adult at the various times of application. Comparing the means of the adult populations, before treatment application and weeks after, it was observed that there was a significant difference in insecticidal application.

Figure 3 shows the variation in the total number of adult weevils in the treatment plot. It was observed that the pre-application adult weevil population was higher than the population recorded after PTWK application. Following the PTWK application, the highest number of adult weevils was recorded in the 4th week post-application, while the lowest numbers were recorded in the 5th and 6th weeks. These are clear indications that the treatment was more effective as a result of prolonged exposure of the adult weevils to the treatment and that the potency of the PTWK treatment increases over time.

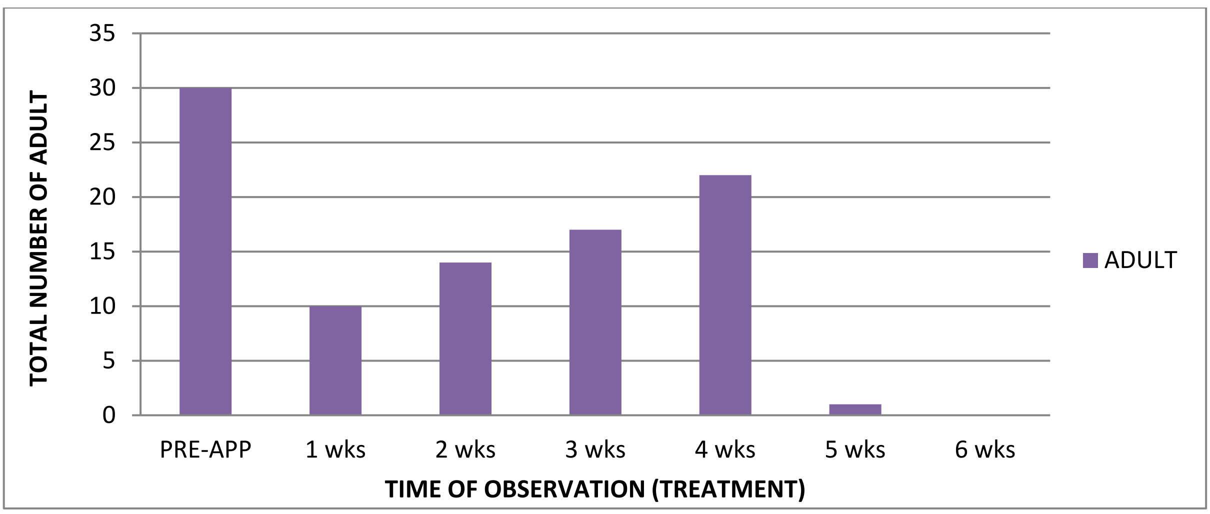

Figure 3. Number of Adult Weevils in Treatment Plot.

Figure 4 shows the variation in the total number of adult weevils in the control plot. The pre-application observation recorded the highest number of adult weevils. Weeks 1 to 6 further showed varying population levels, and the changes in the population of adult weevils may be attributed to natural causes.

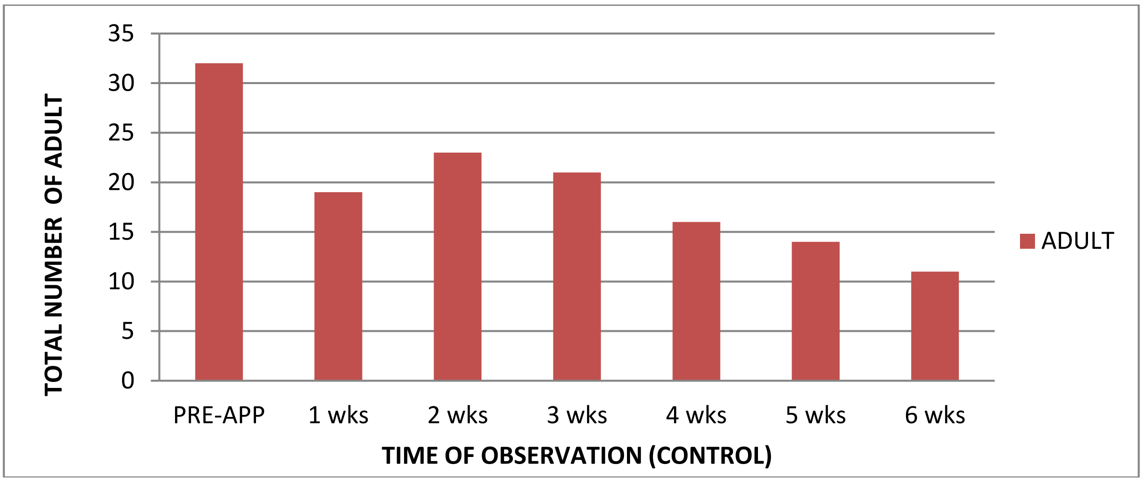

Figure 4. Shows the Number of Adult weevils in the Control Plot.

Table 3. Percentage Mortality of Adult Weevils for Treatment and Control Plots

Treatment period	Study area (%)	Control plot (%)
1 week after treatment	15.6	18.27
2 weeks after treatment	21.88	22.12
3 weeks after treatment	26.56	20.19
4 weeks after treatment	34.4	15.38
5 weeks after treatment	1.56	13.46
6 weeks after treatment	0.00	10.58

Table 3 shows the percentage mortality of adult weevils for both the study area and control plots. One 1week after treatment, adult weevils' mortality rate was 15.6% (treatment area) and 20.4% (control plot), respectively. Two weeks after the second PTWK application (i.e., 4 weeks after the initial application), adult weevil mortality increased to 21.9% (treatment) and 24.7% (control plot), respectively. The highest mortality was observed at the fourth week, with a mortality rate of 34.4 % (treatment area) and 15.38% (control plot) after the application of the second treatment. This was an indication that the treatment was more effective as a result of longer exposure of the adult weevils to the treatment. On the other hand, the lowest mortality rate was observed 6 weeks after treatment application, with a mortality rate of 0.0% (treatment) and 10.58 % (control). This indicated a high level of control achieved by the insecticide.

Table 4. Means of Adult Weevils in Treatment and Control Plots

Observation Time	Treatment Plot	Control Plot
Pre-treatment	0.5	0.6
1 week after treatment	0.2	0.4
2 weeks after treatment	0.3	0.5
3 weeks after treatment	0.4	0.5
4 weeks after treatment	0.5	0.4
5 weeks after treatment	0.0	0.3
6 weeks after treatment	0.0	0.2

A summary of the adult weevil population in the study plots is presented in Table 4. The highest number of dead adult weevils (0.5) was recorded 4 weeks after insecticidal treatment. This indicates that the insecticide knock-down action is most potent 4 weeks after application, and a second insecticide application is required to complement the first application. No dead adult weevils were observed 6 weeks after the treatment. In contrast, the control plot and the pre-treatment observations had adult weevils throughout the duration of the study.

Figure 5. Dead adult weevils.

4. Conclusion

The mortality of adult weevils recorded in this work could be attributed to the toxicity of the PTWK migration through the palm leaflets. It is concluded that PTWK could effectively reduce adult palm weevil population with the least pollutive effects to the environment, and did not reduce the population of other beneficial insects.

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