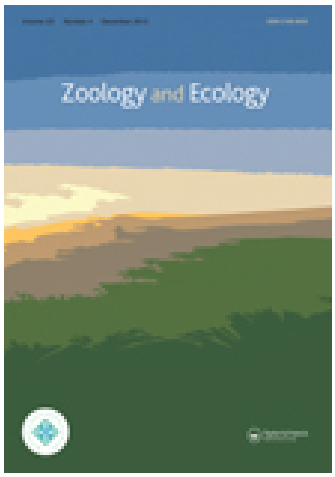

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Oil palm inflorescence (Elaeis guineensis Jacq.) ash and pirimiphos-methyl dust application for control of Oryzaephilus surinamensis infestation on stored date palm fruit (Phoenix dactylifera)

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Oil palm inflorescence (*Elaeis guineensis* Jacq.) ash and pirimiphos-methyl dust application for control of *Oryzaephilus surinamensis* infestation on stored date palm fruit (*Phoenix dactylifera*)

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The efficacies of male oil palm inflorescence ash (OPIA) and pirimiphos-methyl dust (PMD) were assessed for possible control of *Oryzaephilus surinamensis* infestation of the date palm fruit *Phoenix dactylifera*. Male OPIA at concentrations of 0.625 g/25 g of fruit and 1.25 g/25 g as well as PMD at the prescribed dosage of 0.0125 g/25 g were tested on pristine and simulated dates using four replicates per treatment for exposure periods of 5 and 10 weeks. Efficacy was measured on the rate of mortality and emergence of *O. surinamensis* at various development stages. Results showed increased larval and adult mortality on both pristine and simulated dates and decreased larval and adult emergence of the pest exposed to 1.25 g of OPIA. Five days exposure to PMD recorded a significantly high mean mortality of adult *O. surinamensis* and no emergence. The authors concluded that exposure to OPIA at the concentration of 1.25 g/25 g for five weeks could be used in possible control of *O. surinamensis* infestation of palm date fruit with mechanical damages during storage.

Įvertintas aliejinių palmių vyriškųjų žiedynų pelenų ir pirimifos-metilo dulkių poveikis finikinės palmės (*Phoenix dactylifera*) vaisių kenkėjo *Oryzaephilus surinamensis* mirtingumui ir išsiritimui įvairiais vystymosi etapais. Po keturis pakartojimus atliekamuose 5 ir 10 savaičių trukmės bandymuose buvo naudojama 0,625 g/25 g datulių ir 1,25 g/25 g datulių aliejinių palmių vyriškųjų žiedynų pelenų dozė bei 0,0125 g/25 g datulių pirimifos-metilo dulkių dozė. Tyrimai parodė, kad 1,25 g aliejinių palmių žiedynų pelenų naudojimas 25 g datulių apsaugai padidino *O. surinamensis* mirtingumą bei sumažino lervų ir suaugėlių išsiritimą. Penkių dienų trukmės pirimifos-metilo dulkių poveikis labai padidino vidutinį *O. surinamensis* suaugėlių mirtingumą ir visiškai sustabdė šių kenkėjų išsiritimą. Autoriai padarė išvadą, kad 5 savaites trunkantis 1,25 g/25 g datulių koncentracijos aliejinių palmių žiedynų pelenų poveikis gali padėti kontroliuoti *O. surinamensis*, kenkiančius finikinės palmės vaisiams.

Keywords: pirimiphos-methyl dust; saw-toothed grain beetle; emergence; mortality; male oil palm inflorescence ash

Introduction

Oryzaephilus surinamensis, the saw-toothed grain beetle (Coleoptera: Silvanidae), as a pest of stored grain can damage a mass of grain significantly at high population densities, which requires a wide use of insecticides in warehouses. The hosts of the beetle range from cereals, cereal-based products, copra, spices, nuts to dried fruit, with the following host parts most often affected, namely fruit, pods, seeds and grains at the post-harvest stage (Factsheet Bioearfrinet 2011).

The date palm *Phoenix dactylifera* has long been one of the most important fruit crops in the arid regions of the Arabian Peninsula, North Africa and the Middle East. It was also introduced in new production areas in Australia, India/Pakistan, Mexico, Southern Africa, South America and the USA during the past three centuries (Nixon 1951) and it is marketed worldwide as a high-value confectionery.

Date fruit is a good source of iron, potassium and calcium, with a very low sodium and fat content. However, moderate quantities of chlorine, phosphorous, copper, magnesium, silicon and sulphur are also found in date fruit (Zaid and de Wet 2002). Date palms are able to produce many products which are useful to humans. Its primary product, which is the date fruit, can be eaten fresh, dried, or in various processed forms such as juice, vinegar, wine, beer, sugar, syrup, honey, chutney, pickle, paste, dip and food flavouring (Glasner et al. 2002).

Dates are often stored by farmers in locally available materials ranging from baskets made of palm leaflet, goatskins and drums for protection against pests (FAO 1993). Stored dates are often damaged by insect pests such as *Oryzaephilus surinamensis* (Linnaeus) with its destructive qualities caused by larval and adult stages (Al-Zadjali, Fathi, and Haider 2006; Factsheet Bioearfrinet 2011).

Various instances of the use of oil palm inflorescence (*Elaeis guineensis* Jacq.) ash (OPIA) in protecting agricultural produce against insect infestation during storage have been reported in Nigeria and other parts of the tropics (Ayodele and Iwhiwhu 2011; Nwonwu 2011;

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Wilson 1989). However, there is a dearth of knowledge of the use of this ash for protection of date palm fruit in storage. We investigated the use of this ash alongside with pirimiphos-methyl, a synthetic insecticide with a record of good insecticidal prosperities against beetles, moths and mites and low human toxicity.

Materials and methods

Source of insect pest, date palm fruit and processing

O. surinamensis were collected from previously infested date fruit purchased from Sabo market located at the latitude of 7°24′N and the longitude of 3°53′E, Mokola, Ibadan, Oyo state. The beetles were used to raise the culture stock in a 500-ml specimen bottle covered with muslin cloth and fastened with a rubber band for a period of three months at room temperature. Subsequently, *O. surinamensis* used in this research work were collected from such raised stock culture. The date palm fruit (*P. dactylifera*) was purchased from the same Sabo market, Mokola, Ibadan. The dates were heat sterilized in a Gallencamp hot box oven at 60 °C for three hours to remove any pre-infested pest on the fruit. Holes were bored in pristine dates to mimic infestation for simulated date treatment. This enabled the insect pests to infest since they were secondary pests. The experiment was laid out in a completely randomized design with four replicates.

OPIA preparation

Male inflorescences of oil palm (*E. guineensis* Jacq.) used for this research were collected from an oil palm Plantaintion in Mayflower College Ikenne, Ogun state, Nigeria. The inflorescences were dried and burnt to ash indirectly in an aluminium pot on a fire wood source, and this was subsequently used for treatment of the prepared dates.

Application of inflorescence ash on date palm fruit

The weighed 25 g of pristine and simulated date fruit in 24 places each were introduced into 200-ml specimen bottles. Thereafter, the weighed 0.625 and 1.25 g of OPIA were admixed with 25 g of pristine and simulated dates separately. The mixtures of dates and OPIA were shaken thoroughly to ensure adequate mixing. Thereafter, 10 laboratory reared adult *O. surinamensis* were introduced into the OPIA treated pristine and simulated dates in the specimen bottles. Vaseline was applied around the inner top surface of the bottles to prevent the pests from crawling out of the treatment. Muslin cloth was used to cover the bottles; it was fastened tightly with a rubber band to allow proper aeration and to prevent contamination of the set-up and escape of the pests. Another set-up without OPIA treatment was used as a control. These set-ups were kept in cages (60 × 30 × 30 cm) free from rodents and other insects for a period of 5 and 10 weeks. This was to allow a complete life cycle to bring about emergence and other biological activities as it is expected in pest natural environment. After a period of infestation, emergence (larval and adult) and adult mortality rate of *O. surinamensis* were determined on date fruit.

Application of pirimiphos-methyl dust on dates

The weighed 25 g of pristine and simulated date fruit in 24 places each were introduced into 200-ml specimen bottles. Pirimiphos-methyl dust (PMD) was used to further treat the set-up. A prescribed dosage of 0.0125 g/25 g of PMD was applied on the dates. After applying the dust, each specimen bottle was carefully shaken thoroughly to ensure mixing, after which 10 adult *O. surinamensis* were added to each specimen bottle. The set-ups were then covered with black nylon to allow proper infusion of chemical vapour and prevent escape of insect pests. The set-ups were then stored in cages (60 × 30 × 30 cm) free from rodents and insects for a period of five days at room temperature. After a period

Table 1. Effect of 0.625 g and 1.25 g OPIA on adult mortality, larval and adult emergence of *O. surinamensis* on 25 g of stored date palm fruit.

Treatment concentrations (g)	Exposure period (weeks)	*O. surinamensis* infestation on pristine date			*O. surinamensis* infestation on simulated date		
		Emergence			Emergence		
		Larval (mean ± SE)	Adult (mean ± SE)	Adult mortality (mean ± SE)	Larval (mean ± SE)	Adult (mean ± SE)	Adult mortality (mean ± SE)
OPIA 0.625	5	0.00 ± 0.00	0.00 ± 0.00	8.00 ± 1.68^{b}	5.75 ± 3.09^{a}	1.75 ± 1.18^{a}	7.00 ± 0.71^{bc}
OPIA 1.25		0.00 ± 0.00	0.00 ± 0.00	10.00 ± 0.00^{b}	2.25 ± 1.44^{a}	0.00 ± 0.00^{a}	9.00 ± 0.41^{c}
Control		0.00 ± 0.00	0.00 ± 0.00	3.00 ± 1.08^{a}	4.25 ± 2.66^{a}	3.75 ± 1.49^{a}	1.75 ± 0.25^{a}
OPIA 0.625	10	0.00 ± 0.00	0.00 ± 0.00	9.50 ± 0.50^{b}	7.00 ± 2.80^{a}	38.50 ± 4.94^{bc}	8.25 ± 1.18^{c}
OPIA 1.25		0.00 ± 0.00	0.00 ± 0.00	9.50 ± 0.50^{b}	4.75 ± 1.89^{a}	22.00 ± 10.96^{ab}	9.50 ± 0.50^{c}
Control		0.00 ± 0.00	0.00 ± 0.00	7.00 ± 1.08^{b}	6.25 ± 0.63^{a}	51.50 ± 11.44^{c}	5.25 ± 0.25^{b}
F-value		–	–	7.27*	0.56	10.04*	20.76*

Notes: Each mean value is replicated four times.
Means followed by the same letters are not significantly different (SNK) ($p < 0.05$).
*Indicates significant difference at $p < 0.05$ (ANOVA).

Table 2. Effect of PMD CAPL® on adult mortality, larval and adult emergence of *O. surinamensis* on 25 g of stored date palm fruit.

		O. surinamensis infestation on pristine date			*O. surinamensis* infestation on simulated date		
		Emergence			Emergence		
Treatment concentrations (g)	Exposure period	Larval (mean ± SE)	Adult (mean ± SE)	Adult mortality (mean ± SE)	Larval (mean ± SE)	Adult (mean ± SE)	Adult mortality (mean ± SE)
PMD	5 days	0.00 ± 0.00	0.00 ± 0.00	9.75 ± 0.25^{b}	0.00 ± 0.00^{a}	0.00 ± 0.00^{a}	8.88 ± 0.64^{c}
Control	5 weeks	0.00 ± 0.00	0.00 ± 0.00	3.00 ± 1.08^{a}	4.25 ± 2.66^{a}	3.75 ± 1.49^{a}	1.75 ± 0.25^{a}
Control	10 weeks	0.00 ± 0.00	0.00 ± 0.00	7.00 ± 1.08^{b}	6.25 ± 0.63^{a}	51.50 ± 11.44^{c}	5.25 ± 0.25^{b}

Note: Each mean value is replicated 4 times.
Means followed by the same letters are not significantly different (SNK) ($p < 0.05$).

of infestation, the adult mortality rate of *O. surinamensis* was determined.

Statistical analysis

ANOVA and Student–Newman–Keuls Test (SNK) at $p > 0.05$ were applied for analysis and comparison of results from different treatments and exposure periods.

Results

Insecticidal effect of OPIA

The results of insecticidal effect of OPIA on infestation of stored dates (pristine and simulated) with *O. surinamensis* for 5 and 10 weeks are shown in Table 1. The results revealed that exposure to OPIA recorded a significant mortality of *O. surinamensis* on pristine dates compared with the control (ANOVA). Exposure to 1.25 g of OPIA was found to record the highest mortality of 10.00 ± 0.00 on pristine dates. Subsequently, larval and adult emergence of the pest was not recorded on pristine dates since zero mean values were recorded. On simulated dates, larval emergence was not significantly different in the set-up using SNK. However, we recorded zero adult emergence, and mortality was found to show a significant difference at $p < 0.05$ using ANOVA.

Insecticidal effect of PMD CAPL®

Table 2 shows a significant mortality of *O. surinamensis* on pristine and simulated dates when compared with the five weeks control, while larval and adult emergences were not found on pristine dates since zero mean values

Table 3. Effect of 0.625 g of OPIA and PMD CAPL® on adult mortality, larval and adult emergence of *O. surinamensis* on stored date palm fruit.

				Emergence	
Treatment	Exposure period (weeks)	Date palm status	Adult mortality *t*-value	Larval *t*-value	Adult *t*-value
OPIA vs. PMD CAPL®	5	Pristine	1.48 NS	ND	ND
OPIA vs. PMD CAPL®	10		0.51 NS	ND	ND
OPIA vs. PMD CAPL®	5	Simulated	1.80 NS	2.77 NS	2.21*
OPIA vs. PMD CAPL®	10		0.51 NS	3.73 NS	11.61*

Note: ND – not determined (zero values were recorded); NS – not significant.
*Indicates significant difference $p < 0.05$ (*t*-test).

Table 4. Effect of 1.25 g of OPIA and PMD CAPL® on adult mortality, larval and adult emergence of *O. surinamensis* on stored date palm fruit.

				Emergence	
Treatment	Exposure period (weeks)	Date palm status	Adult mortality *t*-value	Larval *t*-value	Adult *t*-value
OPIA vs. PMD CAPL®	5	Pristine	0.69 NS	ND	ND
OPIA vs. PMD CAPL®	10		0.51 NS	ND	ND
OPIA vs. PMD CAPL®	5	Simulated	0.13 NS	2.34*	ND
OPIA vs. PMD CAPL®	10		0.63 NS	3.75 NS	2.99 NS

Note: ND – not determined (zero values were recorded); NS – not significant.
*Indicates significant difference at $p < 0.05$ (*t*-test).

were recorded. On simulated dates, the larval emergence of the pest was not significantly different among the treatments, while adult emergence was significant at $p < 0.05$ (SNK) when compared with the 10 weeks control.

Comparison between efficacy of OPIA (0.625 and 1.25 g) and PMD on O. surinamensis *in stored date palm fruit*

The results of comparison between the efficacy of OPIA treatment (0.625 and 1.25 g) and PMD treatment are shown in Tables 3 and 4, respectively, using *t*-test. In pristine dates, the mortality of *O. surinamensis* exposed to both concentrations of OPIA for 5 and 10 weeks of exposure was not significant compared with exposure to PMD, while larval and adult emergence was not determined due to the zero observations recorded. On the other hand, in simulated dates a significant difference was recorded for adult emergence (using 0.625 g of OPIA at 5 and 10 weeks exposure) and larval emergence (using 1.25 g of OPIA in 5 weeks). However, pest mortality was not significant on simulated dates.

Discussion

The saw-toothed beetle *O. surinamensis* has been identified as a pest of date palms with a wide geographical distribution worldwide. Consequently, adequate control measures to reduce this pest population are therefore needed. Due to the poor financial status of farmers and low income of traders who cultivate and trade in this crop, an effective and cheap control method is thus required. Furthermore, there is a dearth of information on the mode of action of OPIA. However, its efficacy may be linked to the 4% or higher amount of potassium present in the ash as reported by Wilson (1989), or high caustic soda (sodium hydroxide) in the ash as reported by Nwonwu (2011). In this study, significant mortality of *O. surinamensis* was recorded on both pristine and simulated dates exposed to OPIA. Increased concentration of OPIA increased the mortality rate of the pest. Also, increase in the exposure period reduced the insecticidal potential of the ash. Consequently, it reduced its efficacy and caused a lower impact on the insect. From this study, we can see that exposure to 1.25 g of OPIA for five weeks was found to be more effective on both pristine and simulated dates. We recorded high mortality of the pest on pristine and simulated dates and the lowest larval emergence and zero adult emergence on simulated dates. The zero larval and adult emergence of *O. surinamensis* on pristine dates at both concentrations of OPIA may be attributed to the nature of *O. surinamensis*, which is a secondary pest that does not infest pristine grains or dates.

PMD has been reported to be effective in the control of beetles, specifically *T. castaneum* and *O. surinamensis*, moths and mites (Subramanyam and Harein 1990). However, this research recorded an insignificant difference in larval emergence in simulated dates.

On the other hand, comparing the efficacy of OPIA of both concentrations for two exposure periods with the efficiency of PMD, an insignificant difference was recorded in *O. surinamensis* mortality on pristine dates. While larval and adult emergences were not determined in pristine dates as a result of zero observations recorded. In simulated dates, adult emergence was also recorded to show a significant difference when comparing exposure to 0.625 g of OPIA for two exposure periods with exposure to PMD using *t*-test. However, larval emergence after five weeks of exposure to 1.25 g of OPIA was found to be significantly different. The effect of exposure to OPIA of both concentrations during both exposure periods compared with exposure to PMD was relatively the same on pest mortality in both date palm statuses. However, some significant difference was recorded on larval emergence (simulated dates) after five weeks exposure to 1.25 g of OPIA and on adult emergence (simulated dates) after 5 and 10 weeks of exposure to 0.625 g of OPIA. While differences in adult emergence after five weeks of exposure to 1.25 g of OPIA compared with exposure to PMD were not determined.

The outcome of this research provides useful information which suggests that application of OPIA at the concentration of 1.25 g/25 g within five weeks of storage may help in possible control of *O. surinamensis* on palm date fruit during infestation in storehouses. This will help reducing pest population below the economic threshold and ensuring high-quality palm date fruit at high market values.

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