COOPERATIVE EXTENSION
UNIVERSITY OF HAWAI'I AT MĀNOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

Preliminary Trials on Use of Essential Oils for IPM of Coconut Rhinoceros Beetle

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BACKGROUND

Coconut Rhinoceros Beetle (*Oryctes rhinoceros* L., CRB) was first detected on O'ahu in 2013 but since then has become a major pest of coconut and palm species. CRB eat the meristem (e.g., growing tissue) located in the middle of the palm crown, causing either leaf damage or possibly complete crown death. Management of CRB can take an integrated pest management (IPM) approach of various preventative, cultural, physical, biological, or chemical practices. Current management focuses on the palm tree to target adults with the use of synthetic insecticide sprays, injections, or soil drenching. However, practices to control CRB can be limited for certain growers who do not use synthetic insecticides.

Essential oils have been reported in India to cause mortality of CRB larvae and adults. Preliminary trials on O'ahu indicated that essential oils have the potential to be used as an IPM practice for CRB management (Fig. 1). Below are results from preliminary trials for use of essential oil on CRB control.

OIL TYPES AND RESULTS FROM PREVIOUS STUDIES

Previous research from India (Ravindran et al, 2019) revealed that essential oils extracted from basil (*Ocimum basilicum*), eucalyptus citriodora (*Eucalyptus citriodora*), ajowan (*Trachyspermum ammi*) and thyme (thymol oil derived from *Thymus* sp.) caused electrophysiological response in the antennae of O. rhinoceros adults. Behavioral response of beetles was tested in 'Y' tube olfactometer having a choice between an odor arm containing essential oil and a control arm without essential oils. Over 70-85% of the beetles moved towards the control arm, indicating the potential of these essential oils to repel CRB. The same essential oils caused over 90% mortality when beetles were placed in containers lined with a 6% essential oil solution for 48 hours (Figure 1).

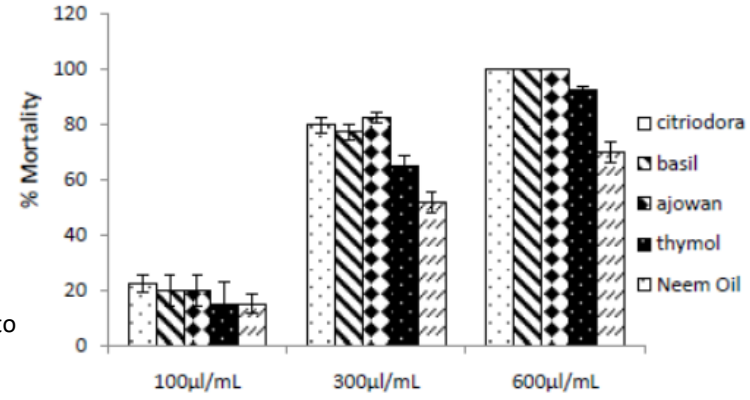

Fig. 1. Contact toxicity of essential oils to adult O. rhinoceros (Ravindran et al, 2019)

TRIALS IN OAHU

O‘ahu County Cooperative Extension ran preliminary and controlled trials to evaluate the efficacy of the oils studied in India on CRB found in Hawaii.

PRELIMINARY FIELD TRIALS: EUCALYPTUS OIL SPRAYED AT COCONUT PALM CROWNS

On 11/02/2023, several coconut trees with CRB symptoms on the North Shore of O‘ahu were trimmed and sprayed with a solution of 6% *Eucalyptus citriodora* oil and Excel 90 spreader-sticker at manufacturer’s recommended rate (1/2 ounce per gallon). A 1-gallon pump sprayer was used to spray directly inside holes bored by CRB and to cover palm frond stems (Figure 2). Two beetles retreated from the crown of one palm. One beetle appeared dead once collected from the ground, while the second beetle was still alive and active. The beetles were transferred to an uncovered container and sprayed with the solution. Both beetles were dead 2 hours after sprayed with 6% solution of eucalyptus.

Fig. 2. Tree climber spraying the crown of a coconut palm crown with CRB damage using a pump sprayer.

On 11/16/2023, five coconut palms at the Department of Urban Forestry nursery in Waipi‘o were trimmed and searched for CRB adults. Only one adult was found, placed on a jar, and lightly sprayed with 6% ajowan oil. The CRB beetle sprayed with 6% ajowan oil was reported dead 4 hours after spray.

CONTROLLED CONDITIONS TRIAL: CRB ADULTS AND LARVAE SPRAYED WITH BASIL AND EUCALYPTUS OIL

On 11/07/2023, CRB adult and larvae were collected from a mulch pile in Wai‘anae. The mulch pile was approximately 40” tall, with a mix if chipped wood and leaves (Figure 3). Pitchforks and rakes were used to graze though the mulch. Most of the larvae were found in the bottom layer near ground level, in fine mulch and compost. Adults were mostly found in coarse mulch in the upper half of the pile. The collected CRB were kept with mulch, overnight, indoors, in coolers and buckets.

Fig. 3. CRB adults and larvae were collected from a mulch pile in Waiʻanae, on the west side of Oʻahu.

Adults and larvae were sorted and placed in containers for treatment approximately 18 hours after collection (Figures 4 and 5). At this point, less than 2.5% of adults (1 of 40) and larvae (2 of over 100) were dead (note: most of the dead specimens had signs of injury from collection).

CRB were sorted into 3 growing stages:

- Larvae 1st to 2nd instar, 5 larvae per container
- Larvae 3rd instar, 5 larvae per container
- Adults, 3 beetles per container

Treatments (3 repetition each):

- Control (tap water only)
- Basil essential oil 6% + spreader-sticker
- Eucalyptus citriodora essential oil 6% + spreader-sticker

Fig. 4. Trial setup.

Fig. 5. Larvae 1st to 2nd instar (left), larvae 3rd instar (center), and adults (right), ready for treatment.

Each container was treated with 3 sprays of the respective solution. Beetle mortality was assessed at 5, 10, and 30 minutes, and 1, 2, 3, 4, and 24 hours after treatment. Larvae mortality was assessed at 30 minutes, and 1, 2, 3, 4, and 24 hours after treatment.

On 11/09, 48 hours after the initial treatment, live beetles and larvae were treated again. They were transferred to a clean container, sprayed 5 five times to ensure the beetles were coated with the solution, and then transferred to the same container they were kept before, with clean mulch from the same mulch pile added to the containers. This was to simulate a beetle fully coated with the solution that retreated from the bored hole in the coconut crown then hid into mulch. The beetles and larvae were evaluated 3 hrs, 24 hrs, and 96 hrs after treatment.

Results from trial in controlled conditions

Larvae in 1st and 2nd Instar

Larvae in the 1st and 2nd instar sprayed with basil and eucalyptus oil had 73% and 100% mortality rate after 30 minutes, respectively, in the first treatment. Basil caused 100% mortality rate after 1 hr, also in the first treatment. Control treatment caused no mortality after 4 hours (all larvae in the control treatment remained alive).

Larvae in 3rd Instar

All larvae in the 3rd instar remained alive 48 hours after the first treatment. After 96 hours in the second treatment, basil caused 20% mortality rate (1 per replicate), and one larvae died in one of the control treatment replicate.

Beetles

All beetles remained alive 48 hours after the first treatment. This was unexpected, since previous research and preliminary field trials indicated that beetles were supposed to die. One hypothesis is that beetles were not sprayed with enough solution to cause their death. After the second and heavier treatment, all beetles in the control treatment remained alive and active after 96 hours. Basil caused 22% and 66% mortality rate after 24 hours and 96 hours (second treatment), respectively (figures 6 and 7). Eucalyptus oil caused only 1 beetle to die 24hrs after treatment. These results indicate that basil essential oil has the potential to be part of an Integrated Pest Management for control of CRB in Hawai'i, and further studies are necessary to confirm its efficacy and applicability to field use.

96 HRS Grouping Information Using the Tukey Method and 95% Confidence

Treatment	Mortality Mean	Grouping
Basil	66 %	A
Eucalyptus	11%	A B
Control	0	B

Means that do not share a letter are significantly different.

Fig. 6. CRB Adults mortality 96 hours after second treatment.

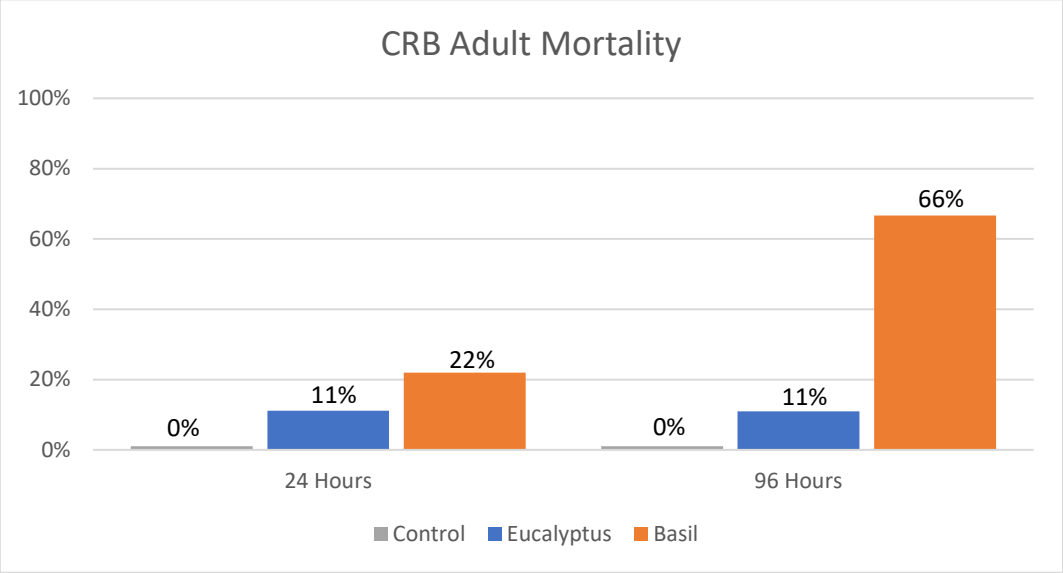

Fig. 7. CRB Adults mortality 24 and 96 hours after second treatment.

FUTURE WORK

As essential oil use is only one practice of an integrated pest management approach and this is the first time it was evaluated in Hawai'i, future research is looking into field applications, optimal concentration rates, and methods of application. Other products and essential oils must be tested to compare effectiveness, including clove, thyme, insect repellents, and pesticide rotation studies. Be on the lookout for news of these other IPM approaches in the pipeline.

ACKNOWLEDGMENTS

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REFERENCES

Ravindran, P., Subaharan, K., Venugopal, V., Chandran, K. P., Prathibha, P. S., & Sujithra, M. (2019). Essential oil in management of coconut rhinoceros beetle Oryctes rhinoceros L. In Indian Journal of Entomology (Vol. 81, Issue 3, p. 603). Diva Enterprises Private Limited. https://doi.org/10.5958/0974-8172.2019.00136.6