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FIELD EVALUATION OF RED PALM WEEVIL *RHYNCHOPHORUS FERRUGINEUS* OLIVIER PHEROMONE LURES

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ABSTRACT

The red palm weevil *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae) is a key pest of coconut. The efficiency of pheromone lures sourced from three countries along with natural (sugarcane) and synthetic (ethyl acetate) co-attractants, was tested in the infested coconut plantation. The results revealed that synergists and co-attractants are essential to sustain trapping efficiency. The best weevil captures were obtained when the pheromone trap had both the natural food bait (sugarcane) and the synthetic co-attractant (ethyl acetate). Pheromone traps with only ethyl acetate as a co-attractant led to lower captures as compared to pheromone traps with only the food bait (sugarcane). In general, the captures were female dominant with an overall male: female ratio of 1:1.35.

Key words: *Rhynchophorus ferrugineus*, ferrugineol, co-attractants, pheromone traps, coconut palm, sugarcane, ethyl acetate, synergist, trap captures, male female ratio

Coconut palm (*Cocos nucifera* L.) occupies a dominant role among the cultivated palm species in India as it provides livelihood securities >10 million people in India. The crop is cultivated in an area of 2.153 million ha with a total production of 21308 million nuts (CDB, 2020). The red palm weevil (RPW) *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae) also known as the Asian palm weevil is a key pest of palms (Arecaceae) in diverse agroecosystems. Globally RPW is reported from 50 countries infecting 40 palm species (Faleiro et al., 2020). Juvenile palms (5-15 years old) are more vulnerable to infestation (Chandrika Mohan et al., 2020). Being an internal tissue feeder, the symptoms are seen at advanced stage of infestation, and hence, early detection/ monitoring of pest is important in IPM approach. Semiochemical mediated control of *R. ferrugineus* is currently confined to the use of food baited pheromone traps (Soroker et al., 2015; Oehchlager, 2016). A good lure would capture more weevils and retain trapping efficiency for long (Faleiro et al., 1999). Fermenting dates, sugarcane, molasses, fresh coconut petiole bits are some of the commonly used food baits in RPW pheromone traps (Faleiro et al., 2020). Ethyl acetate (EA) when incorporated in pheromone traps enhances weevil captures (Oehchlager, 2016). Al-Saoud (2013) reported that black colour pheromone traps along with EA would significantly enhance the efficiency of the mass-trapping programme. In the present study, three RPW pheromone lures from USA, UK and Costa Rica were evaluated for attracting the *R. ferrugineus* along with natural (sugarcane bits) and synthetic (EA) co-attractants.

MATERIALS AND METHODS

The experiment was conducted in *R. ferrugineus* infested coconut plantation at the farm of Don Bosco College of Agriculture, Sulcorna, Quepem Goa, India (15.1060^0 N, 74.1486^0 E) from March 2 to 4 May, 2021. Pheromone traps were fabricated as described in Faleiro (2006) using a 5 l size polypropylene bucket with four uniform rectangular windows (10x 2 cm) cut equidistantly below the bucket rim. The bucket was covered with a lid which was secured to the bucket with wire. The pheromone lure and ethyl acetate dispensers were hung to the lid with a piece of wire so as to firmly remain inside the bucket. The outer surface of the bucket was covered with nylon mesh to facilitate weevils to climb and enter the trap. Buckets were painted black, as black coloured *R. ferrugineus* traps are reported to record significantly higher weevil captures (Al-Saoud, 2013). Main treatment (factor A) comprised of *R. ferrugineus* pheromone (ferrugineol) lures from three countries viz., IT189™ by ISCA Technologies, USA, non-commercial RPW lure by IPS, UK and Ferrolure+™ by Chemtica International, Costa Rica. All three lures are ferrugineol based formulations. While the Chemtica lure is a liquid dispensed through a plastic sachet, the other two lures by ISCA and IPS are wax based capsules.

The subtreatment (factor B) comprised of three treatments including natural (sugarcane bits), synthetic (ethyl acetate) kairomone producing synergist and Combination of both. All treatments contained 1 l water in the bucket trap. The food bait was mixed in the water. One gram carbofuran 3G was added in the water to kill captured weevils and prevent escapes. Where ever applicable, 100 g of sugarcane bits and 10ml ethyl acetate (Ethyl acetate 99.5%, LOBA CHEMIE PVT.LTD.) was incorporated to the trap. While the sugarcane bits were mixed with the water in the trap, 10 ml EA was dispensed in BOROSILR glass vials with a 1mm perforation in the lid of the vial to maintain a release of about 1ml EA/day. Treatment combinations involving *R. ferrugineus* pheromone lures and kairomone producing synergists are as follows: 1. A1B1: ISCA lure (IT189 ™)+ Food bait, 2.A1B2: ISCA lure (IT189 ™)+ Ethyl acetate, 3. A1B3: ISCA lure (IT189 ™) + Ethyl acetate +Food bait, 4. A2B1: IPS lure+ Food bait, 5. A2B2: IPS lure+ Ethyl acetate, 6. A2B3: IPS lure + Ethyl acetate + Food bait, 7. A3B1: Chemtica International lure (Ferrolure+™)+ Food bait, 8. A3B2: Chemtica International lure (Ferrolure+ ™)+ Ethyl acetate and 9. A3B3: Chemtica International lure (Ferrolure+ ™)+ Ethyl acetate+ Food bait.

Treatment traps were set on the ground under the shade of palm canopy about 20m apart in each block. The trial was replicated thrice. R. ferrugineus population is known to be aggregated in nature (Faleiro et al., 2002) which could lead to certain spots in the field capturing more weevils. In order to neutralize treatment bias if any due to spot effect, treatments were allowed to remain at a given spot in the field for 7 days and moved sequentially from one spot to another every week, ensuring that each treatment was placed at every spot in the field for 7 days. Treatment traps were serviced once a week when the food bait, water and insecticide in the bucket traps was renewed and also the EA in the glass vials was replenished. During trap servicing observations on weevil captures gender wise was recorded. The field trial was conducted as a two-factor factorial experiment. The nine treatment combinations in the trial were replicated thrice as indicated above. Treatments within each block were set 20m apart, while a distance of 100m was maintained between replications. A weekly record of the number of weevils trapped in the pheromone traps was maintained gender wise for the study period (2 March- 4 May, 2021). Data on weevil captures recorded every week was compiled at the end of the experiment and subjected to statistical analysis (ANOVA) using the Web Agri Stat Package (WASP1), available at https://ccari.res.in/wasp/index.php

RESULT AND DISCUSSIONS

Results presented in Table 1 reveal that the three pheromone lures (factor-A) tested were statistically at par with regard to the mean weevils trapped which ranged from 3.15 to 3.96 weevils captured/trap/week. As regards the co-attractants (factor-B) evaluated, the best synergistic effect of 6.88 weevils/trap/week was seen when ethyl acetate and the food bait (sugarcane) was incorporated together in the *R. ferrugineus* pheromone traps and was significantly superior in RPW pheromone traps with the food bait (2.75 weevils/ trap/ week) and also with pheromone traps containing EA without the food bait (1.19 weevils/ trap/ week). Further, Table 1 reveals significant interaction effects between the pheromone lure and the co-attractants. The best weevil captures were recorded when the pheromone trap had both the natural food bait (sugarcane) and the synthetic co-attractant (ethyl acetate). Pheromone traps with only EA as a co-attractant recorded lower captures as compared to pheromone traps with only the food bait. In general, the captures were female dominant with an overall male: female ratio of 1:1.35.

Results presented above are in agreement with previous findings. While *R. ferrugineus* pheromone lures may not significantly differ in their attraction to the pest, co-attractants incorporated in pheromone traps are known to play an important role in synergising the efficiency of the lure and enhancing captures. Hallett et al. (1999) first highlighted the importance of adding a food bait to *R. ferrugineus* pheromone traps. Subsequently several workers emphasized the importance of adding food baits (Faleiro and Chellapan, 1999; Hallett et. al., 1999; Nair et. al., 2000). Dates (khajur) when used in the pheromone traps gave the highest captures, which was at par with sugarcane and significantly superior to coconut petiole (Faleiro and Satarkar, 2005). Ethyl acetate when added to food baited *R. ferrugineus* pheromone traps is known to enhance weevil captures by a factor of 2 to 5 (Vacas et al., 2014; Oehlschlager, 2016; Al-Saroj et al., 2017; Amzah and Baki, 2020) and is in agreement with the findings of this study. This study could potentially lead to the development of dry traps that do not need servicing like the Electrap™ (Al-Saroj et al., 2017). Although dry trapping is advancement in *R. ferrugineus* trapping, the need to periodically visit the trap in the field for recording data on weevil captures is another

Table 1. Mean weevil captures in *R. ferrugineus* pheromone traps baited with natural and synthetic co-attractants

No.	Treatment	Mean weevil Captures (catch/ trap/ week)
Factor-A: Pheromone lures		
1	ISCA lure	3.15
2	IPS lure	3.96
3	Chemtica lure	3.70
CD (p=0.05)		NS
Factor-B: Natural and Synthetic Synergists (Sugarcane/ Ethyl acetate)		
1	Food bait (sugarcane)	2.75
2	Ethyl acetate	1.19
3	Ethyl acetate + food bait	6.88
CD (p=0.05)		0.96
Interaction (Factor AxB): Lure x Bait		
1	ISCAlure + Food bait	2.26 (1:1.22)
2	ISCA lure + Ethyl acetate	1.48 (1:1.35)
3	ISCA lure + Ethyl acetate + Food bait	5.71 (1:1.08)
4	IPS lure + Food bait	3.18 (1:3.10)
5	IPS lure + Ethyl acetate	1.19 (1:2.20)
6	IPS lure + Ethyl acetate + Food bait	7.52 (1:1.14)
7	Chemtica lure + Food bait	2.81 (1:0.94)
8	Chemtica lure + Ethyl acetate	0.89 (1:1.14)
9	Chemtica lure + Ethyl acetate + Food Bait	7.40 (1:1.27)
CD (p=0.05) /sex ratio		1.67 (1:1.35)

NS: Difference between mean values not significant; Figures in parentheses sex ratio (male: female) indicating number of female weevils captured for every male weevil trapped.

bottleneck especially in area-wide operations. In this context Spotta UK, has developed a prototype of a smart *R. ferrugineus* pheromone trap that not only eliminates servicing, but also records and automatically transmits weevil capture data on a 24x 7 basis (https://blog-spotta.co/2021-red-palm-weevils-detection-trials). Table 1 also reveals female dominant captures in the trial, which is in agreement with previous findings and good for *R. ferrugineus* control as female weevils trapped in *R. ferrugineus* traps are known to be young, gravid and fertile (Faleiro et al., 2003). Capture of such female weevils would mitigate buildup of the population. Sugarcane bits when added together with ethyl acetate in pheromone traps significantly enhance weevil captures, and addition of ethyl acetate alone could lead to the development of dry traps that do not need periodic servicing.

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AUTHOR CONTRIBUTION STATEMENT

All authors equally contributed.

CONFLICT OF INTEREST

No conflict of interest.

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