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Pheromone traps: An effective tool to manage rhinoceros beetle and red palm weevil in coconut ecosystem

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Abstract
Red palm weevil *Rhynchophorus ferrugineus* Olivier (Coleoptera: Rhynchophoridae) and Rhinoceros beetle *Oryctes rhinoceros* Linn. (Coleoptera: Dynastidae) are most destructive pests in young coconut palms. As application of insecticides and implementation of mechanical or physical methods of pest management are very difficult, use of pheromone technology is the best option in coconut garden. To create awareness about this technology, front line demonstrations were conducted by the Krishi Vigyan Kendra, Vamban during 2013-14 in Pudukkottai district of Tamil Nadu. Rhinoceros beetle trap with rhinolure and red palm weevil trap with ferrolure were erected in the established coconut garden. In six months period, 362 rhinoceros beetles and 266 red palm weevils were trapped in respective traps. At the end of six months, per cent trees with red palm weevil symptoms and rhinoceros beetle symptoms were 24.28 and 15.71 in demonstration and 44.28 and 22.80 in control respectively. Demonstration plot had 21.72 per cent yield increase over control. Net return was Rs. 86,150 in demonstration with BCR of 3.28 as against Rs. 66,190 with BCR of 2.85 in control. The pheromone trap based control measures demonstrated in the coconut garden significantly reduced the tree damage and new infestation was very minimum besides increased yield and income.

Keywords: Coconut, red palm weevil, rhinoceros beetle, pheromone trap, front line demonstration

Introduction
Coconut (*Cocos nucifera* Linn.) known as 'Kalpavriksha' is a major plantation crop provides livelihood securities to millions of small and marginal farmers in India (Rethinam and Singh, 2007) [9]. It plays a major role in social, religious and economic aspects of majority of the Indian rural population. India contributes 22.34 per cent (21892 million nuts) of the world coconut production from 15.53 per cent (2.04 mha) area with the average productivity of 10,736 nuts/ha. It's share in countries GDP is more than US $ 1400 million in addition to US $ 80 million as export earnings. Tamil Nadu ranks third next to Kerala and Karnataka in both area (0.42 mha) and production (5,770 million nuts) with the productivity of 13,717 nuts/ha. The annual growth rate of productivity is mere 0.53 per cent which is comparatively very low. This indicates that a large gap between actual yield and attainable yield for which insect pests are the major reason. Though coconut palm is attacked by a large number of pests, red palm weevil *Rhynchophorus ferrugineus* (Coleoptera: Curculionidae) (Faleiro, 2005) [3] and rhinoceros beetle *Oryctes rhinoceros* (Coleoptera: Dynastidae) (Valentine *et al*., 2007) [12] are serious pests and cause enormous damage to coconut palms. Red palm weevil is the most devastating insect pest in South and Southeast Asia (Abraham *et al*., 2002). [1] According to Faleiro (2005) [3], *R. ferrugineus* damages 12 per cent of young coconut palms (5 to 20 years) in India. As the grubs start feeding from inside the palm and never come outside till adult emergence, detection of pest infestation is noticed when the trees have been severely infested or beyond repair. The damage symptoms include occurrence of small holes on crown and stem along with protruding chewed fibrous material, drying up of the young leaves and splitting of the petioles near the area of attack, presence of fermented odor from the trunk or topping of the crown (Kaahkeh *et al*., 2001) [5]. The rhinoceros beetle adult beetles feed on the growing portion of the palm leading to ragged appearance and when it bores into the base of cluster of spears, causing wedge shaped cuts in the unfolded fronds resulted in reduction of yield and killing of seedlings.
Trunk injection or root feeding of insecticides for red palm weevil and incorporation of granular insecticides into the holes against rhinoceros beetle (Faleiro, 2006) [4] are highly combursum and farmers are reluctant to do because of greater height (usually 10-20 m) of the palms. Insecticide applications leave toxic residues in coconut water posing health hazards (Ranasinghe *et al*., 2003) [8] and the inimical effects on beneficial organisms (Faleiro, 2006) [4]. Implementing the mechanical/physical method is also difficult due the huge structure and architecture of the palms.

Non availability of skilled laborers to execute pest management practices in coconut cultivated tract is another constraint. Under such situation, use of pheromone traps for these pests is ecofriendly, economical, environmentally safe and user friendly without cumbersome. Though the technology is available since 1996, it has not been picked up due to lack of awareness among the farmers. Hence efforts were taken to popularize the technology among farmers through front line demonstrations.

Materials and Methods

Awareness about the use of pheromone traps for the management of rhinoceros beetle and red palm weevil in coconut was created through front line demonstrations at Aranthangi block of Pudukkottai district in Tamil Nadu by the Krishi Vigyan Kendra, Vamban during 2013-14. Bucket traps, rhinolure and ferrolures were purchased from Pest Control India Ltd. Ten demonstrations with field size of one acre each was conducted. Separate garden of same size without pheromone trap was maintained as check. The farmers selected were innovative and receptive with minimum one acre coconut garden and each demonstration was treated as one replication. The technology demonstrated was erection of pheromone traps to attract and trap the rhinoceros beetles and red palm weevils. Rhinoceros beetle trap with rhinolure was erected in the garden at 6 feet height and red palm weevil trap with ferrolure was erected outside the garden to avoid the chance of infestation on nearby trees. One fourth of the bucket in the trap was filled with water and one well ripened macerated banana with 50 gm of castor cake was added to act as food lure for both the sexes. The insects trapped in the water were counted at weekly interval and the content was replaced. Trainings, lectures, orientation and group discussions were conducted to impart knowledge about this technology intervention. Total number of adult rhinoceros beetles and red palm weevils trapped per trap was counted separately at weekly interval and cumulative adults per six months were calculated. At the end of the six months, total number of damaged trees by rhinoceros beetles and red palm weevils were calculated and per cent tree infestation was worked out. Information on yield and cost of cultivation was also recorded for economic evaluation in terms of net profit earned and the benefit cost ratio. Values were statistically differentiated by paired t test method.

Results and Discussion

Table 1: Influence of pheromone traps on incidence and attraction of rhinoceros beetle and red farm weevil in coconut plantations.

Parameters	Demonstration plot	Control plot
No. of Rhinoceros beetles per / trap for 6 months	362	0
No. of Red palm weevil / trap for 6 months	266	0
Per cent trees with red palm weevil symptom*	24.28	44.28
Per cent trees with rhinoceros beetle symptom*	15.71	22.80

*Mean values are significantly different at (P=0.05)

Table 2: Impact of front line demonstrations on the yield and economics of coconut.

Treatment	Yield* (Nuts/ha)	Per cent yield increase	Gross Cost	Gross Return	Net Return*	BCR*
Demonstration plot	20650 nuts	21.72	37750	123900	86150	3.28
Control plot	16965 nuts	-	35600	101790	66190	2.85

*Mean values are significantly different at (P=0.05)

Total number of rhinoceros beetle trapped in six months was 362 and that of red palm weevil was 266. Chakravarthy *et al.* (2014) [2] reported that 80-85 per cent red palm weevil and 72 – 78 per cent rhinoceros beetle population were trapped through the pheromone traps. Rhinolure and ferrolures are aggregation pheromones effective in mass trapping both males and females which implied that the sustained population suppression is possible. This result indicated that there is a huge potential for this pheromone technology to use in the operational programmes to suppress these pests. At the end of six months, per cent trees with red palm weevil and rhinoceros beetle damage symptoms was 24.28 and 15.71 in demonstration and 44.28 and 22.80 in control respectively. This clearly indicated the effectiveness of the pheromone traps in reducing the damage level in coconut garden through attraction of the adults. Economic comparison of the this novel technology with the farmers practices revealed that net returns from the recommended practice were substantially higher compare to farmers practice. The average nut yield was 20,650/ha in demonstration as compared to 16,965/ha in control with per cent increase of 21.72. Net return was Rs. 86,150/ha in demonstration as compared to Rs. 66,190/ha in control. Hence an increase of Rs. 19,960/ha was obtained in addition to the reduction in tree damage which will otherwise lead to death of the tree in future. These benefits could be attributed to the technological interventions provided in on farm trials. Similar trend was observed by Sandeep Kumar *et al.*, (2017) [11] in brinjal. Higher benefit cost ratio in recommended practice (3.28) as compared to farmers practice (2.85) proved the economic viability of the new technology and convinced the stakeholders on adoptability and utility of the new technology provided in real farm situation. This findings coincides with the findings of Mishra *et al.* (2007 and 2012) [6] [7] in onion and cauliflower. Outcome of this front line demonstration conducted clearly proves that dissemination of the pheromone technology is feasible, economically viable and environmentally safe and mass introduction of this technology into coconut system would certainly suppress these coleopteran pests in sustained manner. For wide dissemination of technologies recommended by SAUs and other research institute, more number of FLDs should be conducted (Rupesh Khedkar *et al.*, 2017) [10].

Conclusion

In stabilizing the yield potential with sustained production combined with least risk perception, innovative low cost technologies like this will play a major role. This technology would assure the environmentally safe protection without accumulation of adverse effects. Therefore the knowledge of trap technology must be widely popularised in coconut growing areas through the implementation of front line demonstrations which is the major extension tool for Horizontal spread of improved technologies.

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