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Assessment of damage due to rhinoceros beetle in juvenile and established gardens in Gaja cyclone affected area

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Abstract
Coconut (*Cocos nucifera*) is an important plantation crop and cultivated in all agro ecological conditions in Tamil Nadu. Rhinoceros beetle (*Oryctes rhinoceros* L.) is an important pest that causes damage and reduce the yield. During 2018, Gaja cyclone affected the coconut plantations in delta regions of Thanjavur, Thiruvarur and Nagapattinam Districts. Rhinoceros beetle cause severe damage in replanted young coconut seedlings. In this context, the present study was carried out to assess the damage due to rhinoceros beetle in juvenile and established coconut gardens of Thanjavur, Thiruvarur and Nagapattinam Districts. Rhinoceros beetle incidence was high in hybrid (VHC3) compared to variety (ECT). Low shoot damage of 19.28 per cent and 25.18 per cent was recorded in variety and hybrid respectively in Okkanadu Keelaiyur village in Thanjavur District. However, maximum shoot damage was recorded in Kovilpathu village in both variety (48.57%) and hybrid (55.53%) in juvenile gardens of Nagapattinam District. In established gardens, low leaf damage of 13.74 per cent was recorded in variety at Kulamangalam village and 21.82 per cent in hybrid at Okkanadu Keelaiyur village. However, maximum leaf damage in variety (35.00%) and hybrid (41.23%) was recorded in Kovilpathu village. Low tree damage of 23.39 and 32.14 per cent was recorded in variety at Veppankulam and in hybrid at Okkanadu Keelaiyur village respectively. However maximum tree damage was recorded in variety (42.32%) at Idumbavanam and hybrid (45.89%) at Thillaivilagam village of Thiruvarur District.

Keywords: Damage assessment, rhinoceros beetle, Gaja cyclone, juvenile and established coconut gardens

1. Introduction
Coconut (*Cocos nucifera*) is a member of the palm family (Arecaceae). Considering the adaptable nature and the numerous uses of its products, coconut is eulogized as KALPAVRIKSHA (Tree of Heaven). Coconut is used to make food, beverages, medicines, natural fibres, fuel, timber and raw materials for a wide range of products. India accounts for 72 per cent of global total production and has a high rate of productivity. Tamil Nadu is the top coconut producing state in India. Coconut is a coastal crop and mainly grown in Tamil Nadu, Kerala, Odisha, West Bengal, Karnataka, Maharashtra and Pondicherry. In Tamil Nadu, Cuddalore District dominate in coconut productivity followed by Krishnagiri and Theni. Tiruppur and Thanjavur Districts are dominating in production (Kalimuthu and Raghavi, 2019) [7]. Coconut is prone to damage by a variety of pests *viz*., rhinoceros beetle, red palm weevil, leaf-eating caterpillar, eriophyid mite, whitefly, white grub, and rodents which could cause significant crop damage. *Oryctes rhinoceros* known as the rhinoceros beetle or black beetle is a serious pest of coconut in all coconut cultivating regions (Rajan *et al.*, 2009) [10]. Adults and grubs have different feeding habits (Howard *et al.*, 2001) [5]. Plant damage is caused by adults and not grubs. Grubs live in rotting stumps in the coconut garden and feed on already decomposing material (Gressitt, 1953) [3]. Physical damage caused by adult through feeding on healthy leaves which restrict growth and leads to secondary infections by bacteria or fungi (Hinckley, 1973) [4]. The life period of the beetle is about four to nine months and more than one generation per year (Chandrika Mohan and Nair, 2000) [2]. Adult can lay 70 to 100 eggs (Bedford, 1976) [1]. Adult beetles feed on the soft tissues of the growing region and make burrows in unopened fronds. The opened leaves have a distinct ‘V' shaped geometric cut and the pest occurrence during early phase on juvenile palms highly prevent the good establishment of the palm (Josephrajkumar *et al.*, 2015) [6]. In Coconut yield loss of 5.5 to 9.1% due to rhinoceros beetle attack. Ramachandran *et al*., (1963) [11].

Fallen coconut palms are kept in a heap in farmer's gardens and common sites in villages serve as breeding ground which leads to carry over population of rhinoceros beetles. Rhinoceros beetle kills one third of the young coconut seedlings (Mathirajan, 2020) [8]. Out of 54,133 ha coconut area in Thanjavur, Thiruvarur, Nagapattinam and Pudukkottai Districts, 41,492 ha was affected due to Gaja cyclone during November 2018. Coconut trees were uprooted and farmers replanted the coconut seedlings. The juvenile coconut gardens were severely infested by rhinoceros beetle. The extent of damage caused by the rhinoceros beetle in young seedlings ranged from 21 to 30 per cent (Mathirajan, 2020) [8]. Based on this background, attempts were made to assess the damage due to rhinoceros beetle in juvenile and established gardens.

2. Materials and Methods

Assessment of damage due to rhinoceros beetle was made in juvenile and established garden from March 2021 to October, 2021. Fixed plot survey was carried out in Gaja cyclone affected areas of three Districts *viz*., Thanjavur, Thiruvarur and Nagapattinam to assess the damage caused by rhinoceros beetle in juvenile gardens and established gardens at Veppankulam, Thalikottai villages of Madukkur block and Neiveli north, Pinnaiyur villages of Thiruvonam block and Okkanadu keelayiur and Kulamangalam villages of Orathanadu block in Thanjavur District. In Thiruvarur Disrtict, the study was carried out in Jambuvanodai, Idumbavanam villages of Muthupettai block and Thuraikkadu, Thillaivilagam villages of Thiruthuraipoondi block. In Nagapattinam District, the survey was conducted in Kovilpathu, Vellapallam villages of Thalainayar block and Vaimedu village of Vedaranyam block. Shoot damage was observed in juvenile garden and leaf damage and tree damage was observed in established garden in both coconut hybrid, Veppankulam Hybrid Coconut (VHC 3) and variety, East Coast Tall (ECT). Observation was done in 70 seedlings in juvenile garden and 70 trees in established garden at monthly intervals. Shoot damage, leaf damage and tree damage were worked out as given below

$$\text{Shoot damage (\%)} = \frac{\text{No. of damaged shoots}}{\text{Total number of shoots}} \text{ X } 100$$

$$\text{Tree damage (\%)} = \frac{\text{No. of damaged trees}}{\text{Total number of trees}} \text{ X } 100$$

$$\text{Leaf damage (\%)} = \frac{\text{No. of damaged leaves}}{\text{Total number of leaves}} \text{ X } 100$$

3. Results and Discussion

3.1 Thanjavur District

This study was carried out in six villages of three blocks in variety (East Coast Tall) and hybrid (Veppankulam Hybrid Coconut 3). Shoot damage ranged from 21.96 to 35.54 and 29.64 to 39.46 per cent in variety and hybrid respectively in Madukkur block, 24.90 to 31.61 and 33.93 to 39.64 per cent in variety and hybrid respectively in Thiruvonam block and 19.28 to 22.68 and 25.18 to 28.75 per cent in variety and hybrid respectively in Orathanadu block. The results revealed that the shoot damage in Thanjvaur District in variety and hybrid ranged from 19.28 to 35.54 and 25.18 to 39.64 per cent respectively in juvenile garden.

The shoot damage recorded was high in Thalikkottai village of Madukkur block (35.54%) in variety and Neiveli North village of Thiruvonam block (39.64%) in hybrid and low in Okkanadu Keelaiyur village of Orathanadu block (19.28 and 25.18%) in variety and hybrid respectively in juvenile garden.

In established garden, leaf damage was observed from March to October and it ranged from 13.74 to 27.84 and 21.82 to 36.85 per cent in variety and hybrid respectively in Thanjavur District. Leaf damage ranged from 20.89 to 22.80 and 23.70 to 29.24 per cent in variety and hybrid respectively in Madukkur block, 23.98 to 27.84 and 33.65 to 36.85 per cent in variety and hybrid respectively in Thiruvonam block and 13.74 to 14.02 and 21.82 to 21.94 per cent in variety and hybrid respectively in Orathanadu block. Tree damage ranged from 23.39 to 33.79 and 32.14 to 38.75 per cent in variety and hybrid respectively in Thanjavur District. Tree damage ranged from 23.39 to 33.79 and 33.57 to 35.36 per cent in variety and hybrid respectively in Madukkur block, 28.75 to 28.93 and 34.28 to 38.75 per cent in variety and hybrid respectively in Thiruvonam block and 26.25 to 31.61 and 32.14 to 34.28 per cent in variety and hybrid respectively in Orathanadu block.

The leaf damage recorded was high in variety (27.84%) and hybrid (36.85%) in Neiveli North village and low in Kulamangalam village of Orathanadu block (13.74%) in variety and Okkanadu keelaiyur (21.82%) in hybrid. The tree damage recorded was maximum in Thalikkottai village (33.79%) in variety and Neiveli North village (38.75%) in hybrid and low in Veppankulam village (23.39%) of Madukkur block and Okkanadu keelaiyur (32.14%) in hybrid (Table 1). This study revealed that the rhinoceros beetle incidence was observed higher in juvenile garden compared to established coconut gardens. Nirula (1955) [9] reported one to six years age old coconut seedlings were severely affected. Similarly in Malaysia, one year old young oil palm trees were affected severely (Wood, 1968; Turner, 1981) [14].

3.2 Thiruvarur District

The study was carried out in four villages of two blocks in variety and hybrids. Shoot damage ranged from 27.32 to 33.39 and 32.86 to 42.86 per cent in variety and hybrid respectively in Muthupettai block and 38.86 to 41.89 and 45.71 to 47.50 per cent in variety and hybrid respectively in Thiruthuraipoondi block. The results revealed that the shoot damage of Thiruvarur District in variety and hybrid ranged from 27.32 to 41.89 and 32.86 to 47.50 per cent respectively in juvenile garden.

The shoot damage recorded was high (41.89 and 47.50%) in variety and hybrid in Thillaivilagam village of Thiruthuraipoondi block and low (27.32 and 32.86%) in variety and hybrid in Idumbavanam village of Muthupettai block. In established garden, leaf damage ranged from 24.96 to 31.91 per cent in variety and 28.98 to 37.90 per cent in hybrid in Thiruvarur District. Leaf damage ranged from 24.96 to 28.97 and 28.98 to 36.99 per cent in variety and hybrid respectively in Muthupettai block and 28.87 to 31.91 and 34.98 to 37.90 per cent in variety and hybrid respectively in Thiruthuraipoondi block. Tree damage ranged from 33.21 to 42.32 and 40.00 to 45.89 per cent in variety and hybrid respectively in Thiruvarur District. Tree damage observed ranged from 35.53 to 42.32 and 40.89 to 45.71 per cent in variety and hybrid respectively in Muthupettai block and 33.21 to 33.57 and 40.00 to 45.89 per cent in variety and hybrid respectively in Thiruthuraipoondi block.

The leaf damage recorded was high 31.91 and 37.90 per cent in variety and hybrid respectively in Thillaivilagam village of Thiruthuraipoondi block and low 24.96 and 28.98 per cent in variety and hybrid respectively in Idumbavanam village. The

tree damage recorded was high in Idumbavanam (42.32%) in variety and Thillaivilagam village (45.89%) in hybrid and low in Thillaivilagam village (33.21%) in variety and Thuraikkadu village of Thiruthuraipoondi block in hybrid (40.00%) (Table 2). This study concluded that the incidence was observed higher in juvenile coconut gardens compared to established coconut gardens. Wood (1968) [14] reported that the young seedlings are affected severely than old palm because of narrow spear leaves and easily enter further down and it kills one third of the young coconut seedlings.

3.3 Nagapattinam District

The study was carried out in three villages of two blocks in coconut variety and hybrid. Shoot damage ranged from 45.89 to 48.57 per cent in variety and 49.28 to 55.53 per cent hybrid respectively in Thalainayar block whereas 31.61 and 39.29 per cent in variety and hybrid respectively in Vedaranyam block. The results revealed that the shoot damage of Nagapattinam District in variety and hybrid ranged from 31.61 to 48.57 and 39.29 to 55.53 per cent respectively in juvenile garden. Mathirajan (2020) [8] reported that the seedling damage in coconut ranged from 21 to 30 per cent.

The shoot damage recorded was high (48.57 and 55.53%) in variety and hybrid in Kovilpathu village of Thalainayar block and low (31.61 and 39.29%) in variety and hybrid in Vaimedu village of Vedaranyam block.

In established garden, leaf damage ranged from 28.97 to 35.00 per cent in variety and 31.52 to 41.23 per cent in hybrid respectively in Nagapattinam District. Leaf damage was ranged from 33.06 to 35.00 per cent in variety and 36.60 to 41.23 per cent in hybrid respectively in Thalainayar block and 28.97 and 31.52 per cent in variety and hybrid respectively in Vedaranyam block. Tree damage ranged from 33.04 to 37.75 and 38.03 to 42.14 per cent in variety and hybrid respectively in Nagapattinam District. Tree damage was observed from 33.57 to 37.75 and 41.61 to 42.14 per cent in variety and hybrid respectively in Thalainayar block and 33.04 and 38.03 per cent in variety and hybrid respectively in Vedaranyam block. Srinivasan *et al.* (2018) [12] opined that the leaf and spindle damage of the rhinoceros beetle in coconut were 42.90 and 56.70 per cent respectively in Chowghat Orange Dwarf (COD).

The leaf damage recorded was high 35.00 and 41.23 per cent in variety and hybrid respectively in Kovilpathu village of Thalainayar block and low 28.97 and 31.52 per cent in variety and hybrid respectively in Vaimedu village of Vedaranyam block. The tree damage recorded was high in Vellapallam village of Thalainayar block (37.75%) in variety and Kovilpathu village (42.14%) in hybrid and low 33.04 and 38.03 per cent in variety and hybrid respectively in Vaimedu village.

The results showed that low incidence was observed in Thanjavur District compared to Thiruvarur and Nagapattinam Districts. The shoot damage recorded was high 48.57 and 55.53 per cent in variety and hybrid respectively in Kovilpathu village of Nagapattinam District and low 19.28 and 25.18 per cent in variety and hybrid respectively in Okkanadu keelaiyur village of Thanjavur District.

The leaf damage recorded was high 35.00 and 41.23 per cent in variety and hybrid respectively in Kovilpathu village of Nagapattinam District and low in Kulamangalam village (13.74%) in variety and Okkanadu keelaiyur village (21.82%) in hybrid at Thanjavur District.

The tree damage recorded was high in Idumbavanam village (42.32%) in variety and in Thillaivilagam village (45.89%) in hybrid at Thiruvarur District and low in Veppankulam village (23.39%) and Okkanadu keelaiyur village (32.14%) in hybrid at Thanjavur District (Table 3). Mathirajan (2020) [8] reported that the young coconut seedling was severely affected by rhinoceros beetle.

Table 1: Coconut seedling & tree damage due to rhinoceros beetle in Thanjavur District

Block	Village	Variety (ECT)			Hybrid (VHC3)		
		Shoot damage (%)	Leaf damage (%)	Tree damage (%)	Shoot damage (%)	Leaf damage (%)	Tree damage (%)
Madukkur	Veppankulam	21.96 ± 9.38	20.89±2.26	23.39±5.56	29.64 ± 9.09	23.70±2.77	33.57±4.77
	Thalikkottai	35.54 ± 9.04	22.80±2.47	33.79±4.76	39.46 ± 8.97	29.24±2.17	35.36±4.02
Thiruvonam	Neiveli North	31.61 ± 9.39	27.84±2.28	28.93±4.99	39.64 ± 8.42	36.85±3.31	38.75±4.14
	Pinnaiyur	24.90 ± 8.93	23.98±2.43	28.75±4.67	33.93 ± 8.96	33.65±3.75	34.28±3.49
Orathanadu	Okkanadu keelaiyur	19.28 ± 8.12	14.02±2.20	26.25±3.81	25.18 ± 9.22	21.82±2.40	32.14±3.49
	Kulamangalam	22.68 ± 8.72	13.74±2.34	31.61±4.73	28.75 ± 9.91	21.94±3.98	34.28±5.45

ECT- East Coast Tall; VHC3- Veppankulam Hybrid Coconut 3
Values followed by ± indicated standard deviation

Table 2: Coconut seedling & tree damage due to rhinoceros beetle in Thiruvarur District

Block	Village	Variety (ECT)			Hybrid (VHC3)		
		Shoot damage (%)	Leaf damage (%)	Tree damage (%)	Shoot damage (%)	Leaf damage (%)	Tree damage (%)
Muthupettai	Jambuvanodai	33.39±9.06	28.97±2.31	35.53±4.97	42.86±8.83	36.99±2.35	40.89±5.76
	Idumbavanam	27.32±9.55	24.96±2.35	42.32±4.64	32.86±9.68	28.98±3.16	45.71±6.34
Thiruthuraipoondi	Thuraikkadu	38.86±9.35	28.87±2.46	33.57±4.76	45.71±9.09	34.98±2.48	40.00±3.49
	Thillaivilagam	41.89±9.03	31.91±2.31	33.21±6.04	47.5±8.76	37.90±3.69	45.89±4.35

ECT- East Coast Tall; VHC3- Veppankulam Hybrid Coconut 3
Values followed by ± indicated standard deviation

Table 3: Coconut seedling & tree damage due to rhinoceros beetle in Nagapattinam District

Block	Village	Variety (ECT)			Hybrid (VHC3)		
		Shoot damage (%)	Leaf damage (%)	Tree damage (%)	Shoot damage (%)	Leaf damage (%)	Tree damage (%)
Thalainayar	Kovilpathu	48.57 ±9.84	35.00±2.59	33.57±4.51	55.53±7.80	41.23±2.54	42.14±3.49
	Vellapallam	45.89± 9.05	33.06±2.30	37.75±4.18	49.28±8.94	36.60±3.74	41.61±5.74
Vedaranyam	Vaimedu	31.61± 9.39	28.97±2.31	33.04±4.34	39.29±8.93	31.52±3.33	38.03±3.81

ECT- East Coast Tall; VHC3- Veppankulam Hybrid Coconut 3
Values followed by ± indicated standard deviation

4. Conclusion

The lowest beetle damage was observed in Thanjavur District compared to Thiruvarur and Nagapattinam Districts. The rhinoceros beetle incidence was observed higher in juvenile gardens compared to established coconut gardens whereas incidence was maximum in hybrid (VHC3) compared to variety (ECT).

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