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Efficacy of Certain botanicals against the grubs of coconut rhinoceros beetle, *Oryctes rhinoceros* (L). (Scarabaeidae: Coleoptera)

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Abstract
To manage the grubs of *O. rhinoceros* which are developing in Farm yard manure an experiment was conducted in Semi field condition using neem emulsion, neem oil emulsion, neem seed kernel extract, neem cake and leaf powder of *Annona squamosa* L. (Sugar apple) at various concentrations. High rate of mortality of the grubs was recorded in Neem cake followed by *A. squamosa* powder under semi field condition.

Keywords: rhinoceros beetle, neem emulsion, neem oil emulsion, neem seed kernel extract, neem cake and *a. squamosa*

1. Introduction
Oryctes rhinoceros L. is an important pest of the coconut palm (Catley, 1969) [1]. Coconut palm is growing in more than 90 countries of the world. Traditional area of coconut cultivation in India are the states of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, West Bengal, Maharashtra the islands of Lakshadweep and Andaman and Nicobar (Coconut development board, 2015) [2]. Larva of *O. rhinoceros* develops in manure pit but adults bore into the unopened fronds and spathes. The fully opened fronds showing characteristics of diamond shaped or V-shaped cut. Frequent infestation results in stunting of trees and death of growing point (Sadakathulla and Ramachandran, 1990) [7]. It also attacks inflorescence and causes 26% loss of the fruits in a bunch (Ponnamma *et al.*, 2001) [5]. Management of larval stages by using insecticides is laborious process and addition of insecticides to the farm yard manure may not support organic farming. Hence Botanicals were tested.

In the present study Neem products and *A. squamosa* (Annonaceae) were tried against larvae of *O. rhinoceros* under semi field conditions.

Different parts of *A. squamosa* is used in folkloric medicine for the treatment of various diseases (Suresh *et al.*, 2006) [9]. It is commonly called custard apple (Raj Sobiya *et al.*, 2009) [6].

2. Materials and Methods
Azadirachtin (0.15% ppm) based neem emulsion, neem oil emulsion and neem cake were obtained from the commercial markets.

Neem seed kernel extract was prepared using standard method (TNAU, agriportal, 2016) [10]. The fresh leaves of *A. squamosa* was collected, washed, dried and made into fine powders. These procedure and prepared botanicals were tested against 3rd instar larvae of *O. rhinoceros* under semi field conditions in the pot culture yard of Department of Entomology, Faculty of Agriculture, Annamalai University. *O. rhinoceros* larvae were obtained from laboratory culture.

2.1 Culturing of *O. rhinoceros*
To start the culture, around 50 numbers pupae of *O. rhinoceros* were collected from the heaps of farmyard manure at the animal house, Department of Animal Husbandry, Annamalai University. Collected pupae were placed into round plastic basins of 30cm diameter and 10cm deep, which contained 1kg of a mixture of powdered cow dung and coir pith dust @ 5:1ratio and the mouth of the basins were covered using khada cloth and secured tightly by elastic bands. The culture was maintained under the laboratory at 26±2°C temperature and 70±5% relative humidity. From pupae to adult, it took an average of 34 days. Emerged adults were differentiated based on the abdominal characters such as presence of fuzzy hairs at the tip of the abdomen (female) and smooth and shiny abdomen (male). The sexed adults were released @ 1:1 ratio into transparent round plastic rearing containers of 20 x 20cm in size (diameter and height). Two pairs of adults were introduced per container and ten such containers were maintained in the laboratory. The mouths of the containers were closed with perforated lids. The rearing containers were filled with a layer (3cm thick) of fine sand then by a layer (5cm thick) of coir dust before the introduction of adults. Fresh pieces of coconut frond and pineapple slices were provided as food for adults and reared until death.The average longevity of adults under the laboratory condition was seventy days. After ten days, two cups (100g capacity each) of semi dried farmyard manure were kept per container, as the substrate for egg laying. Once in a week the containers were cleaned. The contents were examined carefully and the eggs laid were separated and incubated until hatching. The eggs were observed under 10x. Average fecundity recorded was 52 eggs/ female. It took an average of 10 days to hatch.

Newly hatched grubs were reared in the laboratory for ten days on semi dried farmyard manure, and then transferred to the heaps of farm yard manure maintained in the pot-culture yard to rear the grubs under semi field conditions. Farmyard manure heaps were prepared for a height of 2.5 feet with a diameter of

3 feet and covered all the sides using nylon mesh. Water was sprinkled daily over the heaps to maintain optimum moisture. Grubs were maintained under semi field conditions until pupation and then recycled as described earlier. Whenever needed grubs of same ages were used in the experiments.

2.2 Bioassay [Semi field]

Round cement pots of 60 x 60cm were filled with two kilograms of semi dried farmyard manure and mixed with selected botanicals at various concentrations such as 20 and 25% of neem emulsion, neem oil emulsion, NSKE (each 50 and 100ml/kg of feed), neem cake 100, 150 and 200g kg of feed and *A. squamosa* 150 and 200g kg of feed. Five numbers of third instar were released in each pot and entire pot was covered using nylon mesh and secured. Each treatment was replicated three times. Observations were done once in 48h and mortality was recorded up to 30 days after treatment. Then the cumulative mortality was worked out.

2.3 Statistical analysis

Analysis was done with ANOVA under completely randomised block design and the means values were compared by following Duncan's multiple range test (DMRT) AT P = 0.05 (Gomez and Gomez, 1984) [3]. Necessary data transformation was made before analysis and the computer based OPSTAT package was used for the calculation.

3. Results and Discussion

The cumulative larval mortality in this experiment is observed higher in neem cake followed by *Annona squamosa*.

In which the highest dose in neem cake @ 200g/kg of feed and in *A. squamosa* @ 200g/kg of feed recorded maximum per cent of cumulative larval mortality.

The third effective botanical was NSKE. Neem oil and azadirachtin based neem emulsion were less effective among all the botanicals.

Our findings are partially in accordance with the finding of Mohan and Padmanaban (2013) [4] who reported LC_{50} (96hours) for the larvae of *O. rhinoceros* were 29.5% for neem cake powder, 24.5% for neem oil and 14.9%.

And for the other botanicals our findings are in corroboration with the report of Sreelatha and Geetha (2012) [8] who explained *A. squamosa* Leaf powder as an effective material in causing larval mortality, pupal mortality and adult formation.

Table 1: Efficacy of selected doses of botanicals against 3rd instar of *O. rhinoceros*

Treatment	Dose/kg of feed	*Percent Cumulative mortality
T_1	Neem emulsion @ 100ml (20%)	46.67 (43.07)^{b}
T_2	Neem emulsion @ 100ml (25%)	50.33 (45.17)^{c}
T_3	Neem oil emulsion @ 100ml (20%)	45.67 (42.50)^{b}
T_4	Neem oil emulsion @ 100ml (25%)	52.67 (46.51)^{d}
T_5	NSKE (20%) @ 100ml	53.33 (46.70)^{d}
T_6	NSKE (25%) @ 50ml	51.33 (45.75)^{cd}
T_7	NSKE (25%) @ 100ml/kg	63.00 (52.52)^{g}
T_8	Neem cake @ 100g	55.67 (48.23)^{e}
T_9	Neem cake @ 150g	68.33 (55.74)^{h}
T_{10}	Neem cake @ 200g	79.67 (63.18)^{j}
T_{11}	*A. Squamosa* @ 150g	58.67 (49.97)^{f}
T_{12}	*A. Squamosa* @ 200g	72.33 (58.26)^{i}
T_{13}	Control	0.00 (0.00)^{a}
	SEd	0.56
	CD(0.05)	1.16

* Mean of 3 replications

Values in parenthesis are arc transformed (x + 0.5)

Values with various alphabets differ significantly.

4. Acknowledgment

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