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Insecticidal efficacy of *Chromolaena odorata* (compositae) on the coconut beetle, *Oryctes rhinoceros* (Linn.)

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ABSTRACT: Different doses of *Chromolaena odorata* plant powder were mixed with cowdung and fed to late third instar grubs of coconut rhinoceros beetle, *Oryctes rhinoceros* (L.). Mortality rates of larval and pupal stages as well as the emergence of deformed adults were recorded. Concentration of 15 and 20% (w/w) plant powder showed 80 and 90% impact respectively on the development of rhinoceros beetle. Topical supply of juvenile hormone analogue, methoprene @ 20 and 30 μg levels to third instar grubs induced 86 and 92% developmental deformities similar to that observed with the supply of 15 and 20% plant powder. Similarity in the induction of morphological deformities in the emerging adults of *O. rhinoceros* by the two treatments indicated the JH mimicking endocrine influence exerted by this plant. These preliminary observations indicate the potential of this common weed for use against *O. rhinoceros*, by incorporating the plant material on the breeding sites of the pest.

KEYWORDS: *Oryctes rhinoceros*, *Chromolaena odorata*,, methoprene

INTRODUCTION

Coconut rhinoceros beetle, *Oryctes rhinoceros* L. (Coleoptera: Scarabaeidae) is a serious and well known pest of coconut palm; the adult beetle bores into the unopened fronds and inflorescence of the palm. Adults breed on cow-dung or decaying organic matter on which the larvae feed. Treatment of breeding sites with insecticides is one of the key components of the IPM package for this pest. Application of insecticidal agent

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at the breeding site, where the insect is relatively stationary, potentially would seem more efficient than other methods of control for the highly mobile adult (Campbell and Wright, 1976). However, this could be harmful to its natural predators and also can cause adverse effects on the environment. The present study was carried out to explore the possibility of eco-friendly management of this pest by incorporating plant product with insect control potential in its natural breeding sites. The plant tested is *Chromolaena odorata* (syn: *Eupatorium odoratum* L). Commonly known as Siam weed, Christmas bush, etc., it is a noxious perennial weed in many parts of the world. It was introduced to India from tropical America during the Second World War and since then it has spread widely and has become a dominant weed of wastelands, roadsides and other exposed areas (Kushwaha *et al.*, 1981). Its medicinal properties are also well known.

Rajamma (1982) showed that the application of *C. odorata* leaves into the soil prior to planting of sweet potato reduces the weevil infestation significantly. The moult inhibiting action and formation of malformed adults as a result of application of *C. odorata* extract on *Dysdercus cingulatus* was reported earlier by Saradamma (1989). Prameela (1997) observed that the application of *C. odorata* extract resulted in the inhibition of normal ovarian development and oocyte maturation in the same insect. During fallows between cultivation, *Chromolaena* adds copious amounts of organic matter to the soil and may reduce the population of nematodes (M'Boob, 1991). It is also an useful mulch for row crops (Swennen and Wilson, 1984). Basin application of *Chromolaena* leaves prior to planting of vegetable seedlings is recommended and followed by vegetable growers of Kerala. In pepper, evaluation of leaf and seed extracts of *Strychnos nuxvomica* and *Chromolaena odorata* were promising indicating their potential for utilizing them in IPM schedules (Devasahayam, 2005).

Keeping the above in view, the present study was undertaken. Studies were also conducted on the effect of synthetic juvenile hormone mimic, methoprene on the development of rhinoceros beetle for comparison of observed symptoms.

MATERIALS AND METHODS

Late third instar *O. rhinoceros* (L.) grubs were used for the experiment. Grubs of different stages of growth were collected from local manure pits, vermi-compost units and felled oil-palm residues and were maintained on cow-dung in the laboratory under controlled conditions. Tender stems and leaves of *C. odorata* were collected from Kariavattom campus and nearby areas, shade-dried and pounded to a coarse powder. This powder @ 5, 10, 15 and 20% (w/w) was thoroughly mixed with sun-dried and powdered cow-dung. Cow-dung without leaf powder served as control. Late third instar grubs with a mean weight of 11.2 g were introduced individually into small plastic containers with 100 g of cow-dung-plant mixture. Water was sprinkled over the feed to provide adequate moisture. The containers were covered with plastic lids with holes. The feed was changed once a week. There were 10 grubs per treatment and the experiment was replicated five times. Observations were made on the development of the larvae and deformities, if any, at three days intervals.

TABLE 1. Effect of *Chromolaena odorata* leaf powder on the development of *Oryctes rhinoceros*

Dosage (%plant powder)	Initial no. of larvae	Larval mortality	Pupal mortality	Total mortality	Deformed adults	Deformity score	Total mortality+ Deformed adults
05	10	1.4	0.4	1.8	1.4	0–1	3.2
10	10	2.6	0.6	3.2	3.2	1–2	6.4
15	10	3.6	1.2	4.8	3.2	2–3	8.0
20	10	6.0	1.2	7.2	1.8	3–4	9.0
Nil (control)	10	0.2	0.0	0.2	0.0	-	0.2

Values represent the mean of 5 replications with 10 larvae each.
General mean: 1.787; S.E: 0.560; CV(%): 21.330
Treatments (T) CD: 0.409; Conditions (C ie., Developmental stages of the insect) CD: 0.317; T X C CD: 0.709.

In another experiment, the effect of juvenile hormone analogue, methoprene on the development of third instar *O. rhinoceros* larva was studied. Methoprene (ZR 515, gift from Dr. Govindan Bhaskaran, A&M University, Texas, USA) was dissolved in acetone so that 1 μl contained 1 μg methoprene and the desired dose (10 μg, 20 μg and 30 μg) was applied to different animal groups of ten each in five replications. The hormone was applied topically on the ventral abdominal segment of third instar larvae. Two sets of control were maintained; one set received only acetone in the same dosages and the other received no treatment at all. All the sets of larvae were maintained on cow-dung as described earlier. The treatments were replicated five times and observations recorded as above.

RESULTS

When third instar *O. rhinoceros* larvae were grown on cow-dung mixed with *C. odorata* leaf powder, the first larval mortality was recorded on the sixth day of treatment. Larval mortality was 60% in 20% leaf powder medium, followed by 36% in 15% leaf powder, 26% in 10% leaf powder and 14% in 5% leaf powder (Table 1). Only 2% larval mortality was observed in untreated cow-dung. In case of pupal mortality, 12% each in 20% and 15% leaf powder was recorded followed by 6% and 4% in 10% and 5% leaf powder, respectively. The percentage of abnormal adults was 32 in 15% and 10% leaf powder, 18 in 20% leaf powder and 14 in 5% leaf powder. Pupal mortality and abnormal adults were not found in control. In 20% leaf powder medium, 90% of the insects were affected either by mortality of larva or pupa or emergence of abnormal adults. The percentage of insects thus affected was 80 in 15% leaf powder, 64 in 10% leaf powder and 32 in 5% leaf powder.

Pupal-adult intermediates were observed in treatments, which were characterized by adult head, pupal wing buds and retension of pupal exuviae. They lived only up to five

TABLE 2. Effect of methoprene on the development of *Oryctes rhinoceros*

Dosage	Initial no. of larvae	Larval mortality	Pupal mortality	Total mortality	Deformed adults	Deformity score	Total mortality+ Deformed adults
10	10	1.2	0.2	1.4	4.8	1–2	6.2
20	10	2.0	0.4	2.4	6.2	3–4	8.6
30	10	3.4	0.8	4.2	5.0	2–3	9.2
Acetone							
30	10	0.0	0.0	0.0	0.0	–	0.0
Nil	10	0.0	0.0	0.0	0.0	–	0.0

Values represent the mean of 5 replications with 10 larvae each.
General mean: 1.573; S.E: 0.510; CV(%): 22.439
Treatments (T) CD: 0.373; Conditions (C) (i.e. Developmental stages of the insect) CD: 0.289; T x C CD: 0.647

days whereas those adults with badly deformed wings survived up to nine days. The emerged adults other than malformed were normal looking but with pale, leathery, unchitinized wings not covering the abdomen fully. Around 80% of them had longevity of 24–30 days. From control larvae, normal adults emerged and lived beyond 95 days. More than 80% of emerged adults were females and abnormal morphological characters were manifested more in females. The pygidium of normal looking and deformed adult females under plant product treatment was not densely packed with reddish-brown sensory hairs whereas it was bushy in control adult females. This may be due to some abnormalities in the reproductive system of treated larvae.

When treated with methoprene, 34% larval mortality was recorded at 30 μg dose, followed by 20% at 20 μg and 12% at 10 μg (Table 2). Pupal mortality was 8%, 4% and 2% respectively at the above doses. Highest abnormal adults (62%) was recorded at 20 μg methoprene followed by 50% at 30 μg and 48% at 10 μg. Treatment with 30 μg methoprene affected 92% of the insects either by mortality of larva or pupa or production of abnormal adults; 20 μg methoprene affected 86% of the insects and 10 μg methoprene affected 62% of the insects. The morphological deformities observed in adults emerged out of this treatment was similar to that produced by exposure to *C. odorata* leaf powder. No larval or pupal mortality or abnormal adults were found in the two controls.

DISCUSSION

From the present results, it is inferred that *Chromolaena odorata* has exerted JH like activity during the metamorphosis of this insect as evidenced through the emergence of adults with varying external deformities, occurrence of pupal-adult intermediates and premature death of adults inside the pupal case. The chemical properties of juvenoids usually allowed them to cross the cuticle and act directly on the insect as a result of contact. Since ingested JH like substances are likely to be digested before absorption,

the effect observed here seems to be due to external skin contact of larvae with the plant material.

Growth regulatory activity including larval and pupal mortality as well as deformation of adults in *Oryctes rhinoceros* was reported with *Clerodendron infortunatum* (Chandrika and Nair, 2000). Further, the results of the present study agree with the findings of Ponnamma (2003) that crushed leaves of *C.odorata*, when mixed with sterilized cow dung and fed to third instar grubs of *O. rhinoceros*, caused abnormalities and prevented proper development of beetles. The insecticidal and insect growth regulatory activity exerted by organic extracts from the leaves of *Vitex mollis* was recently reported by Rodriguez-Lopez *et al.* (2007). Plant kingdom offers an excellent source of secondary metabolites which affect the behaviour, physiology, growth, reproduction and development of insects. Many of them exert repellence effect, feeding deterrence and several other influences. Some affect the hormonal balance of the insects while some others are highly toxic and affect normal physiological processes. Many juvenoids have been isolated from plants and the possibility of using these phytojuvenoids in disrupting the insect developmental processes forms an innovative and effective control strategy for the management of insect pests. The use of these growth regulating compounds would be more appropriate, when the insect is a pest during its adult stage and the larvae develop in a restricted habitat (Elzinga, 2000). The effects produced by *C. odorata* leaf powder and the JHa methoprene on *O. rhinoceros* showed resemblances in their morphological abnormalities indicating the presence of juvenile hormone mimics in the tested plant.

The search and use of safer plant-derived products are increasing now as a viable component of Integrated Pest Management (IPM). Results of the present study suggest the possibility of incorporating *C. odorata*, a common weed plant available in plenty in coconut orchards, in the breeding sites of *O. rhinoceros*, as an ecologically safer, human hazard free, farmer-friendly component among the existing IPM package developed for the management of *O. rhinoceros*.

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