Proc. Indian natn. Sci. Acad. **B54** No. 1 pp. 43–46 (1988)

Effects of Plumbagin on Growth and Development of Red Cotton Bug, *Dysdercus cingulatus* Fab.

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(Accepted on 4 January 1988)

Topical application of 1 to 4 μg of plumbagin, a napthoquinone from *Plumbago zeylanica* to the newly moulted 5th instar nymphs of *Dysdercus cingulatus* retarded growth and delayed metamorphosis in a dose-dependent manner. Metamorphosed adults possessed deformed wings. Treatment of the nymphs with higher doses of plumbagin inhibited moulting. Prothoracic gland cells of such insects were selectively stained blue-black. These observations suggest that plumbagin interferes with the function of prothoracic glands.

Key Words: **Plumbagin,** *Dysdercus cingulatus*, **Growth and Metamorphosis, Prothoracic glands**

Introduction

Recent researches have revealed that several plant products disrupt normal development of insects (Bowers 1985). Plumbagin, a naphthoquinone occurring in plants belonging to genus *Plumbago* has been found to exhibit antifeeding properties (Kubo et al. 1980). Inhibition of ecdysis of some lepidopterous larvae has also been reported (Kubo et al. 1983). In the present study, we show for the first time that in *D. cingulatus* application of plumbagin selectively stains the active prothoracic gland cells and this poisoning may be responsible for the moulting inhibition.

Materials and Methods

Newly moulted (1–2 hr old) 5th instar nymphs of *D. cingulatus* were isolated from culture jars and topically treated with 1 to 10μg of plumbagin in 1μl of acetone. Acetone-treated nymphs served as controls. The nymphs were provided with cotton seeds, water and maintained at 27 ± 1°C. Nymphs were daily observed for mortality and moulting; metamorphosed insects were checked for morphogenetic abnormalities. Some of the plumbagin-treated nymphs were dissected 24 hours after the application and the pathological changes in the prothoracic gland cells were observed under compound microscope.

Results

Deposition of melanin pigments in the wing pads of freshly moulted 5th instar nymphs begins within an hour of moulting and it attains intense black colouration in 3 hours period. However, inhibition of tanning was observed on the treated nymphs even at the lowest dose of 1μg/nymphs. (figure 1). There was a dose-dependent delay in metamorphosis (table 1). Nymphal mortality also increases with the increase in dose. The treated

Table 1 *Effect of plumbagin on survival and metamorphosis of 5th instar nymphs of* Dysdercus cingulatus

Dose (μg/μl/nymph)	Mortality	Interecdysial period	
		Range (hr)	Mean (hr)
1	5.0	144–168	156
2	20.0	186–210	198
3	45.0	200–246	224
4	55.0	240–278	256
(control) Acetone	5.0	140–156	148

20 nymphs are used for each concentration

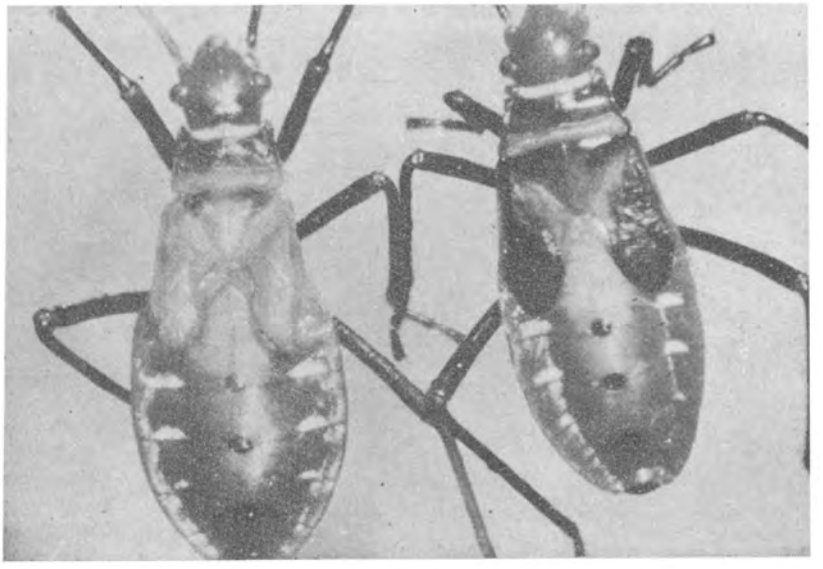

Figure 1 Treated nymph (left side) showing absence of melanin pigment on the wing pads; Control nymph (right side) showing presence of melanin pigment on the wing pads

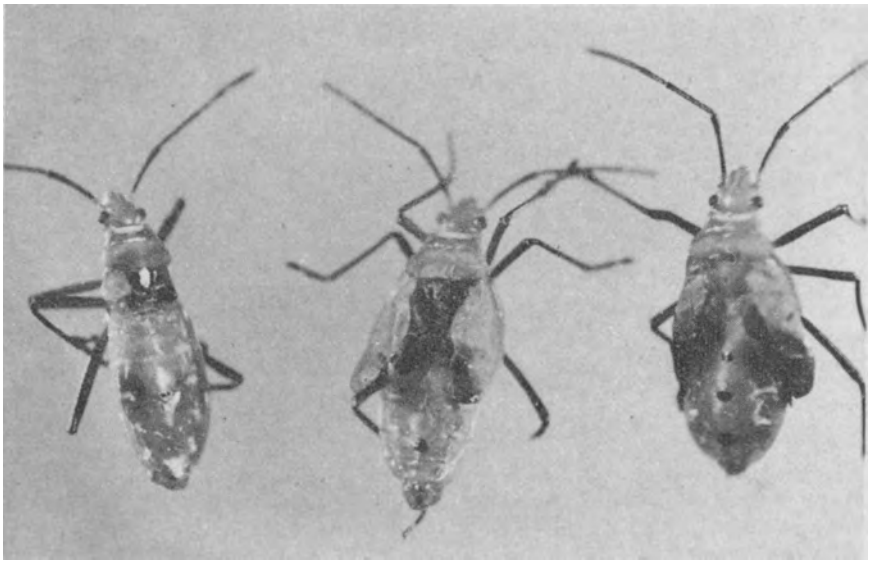

Figure 2 Wing abnormalities caused by Plumbagin treatment

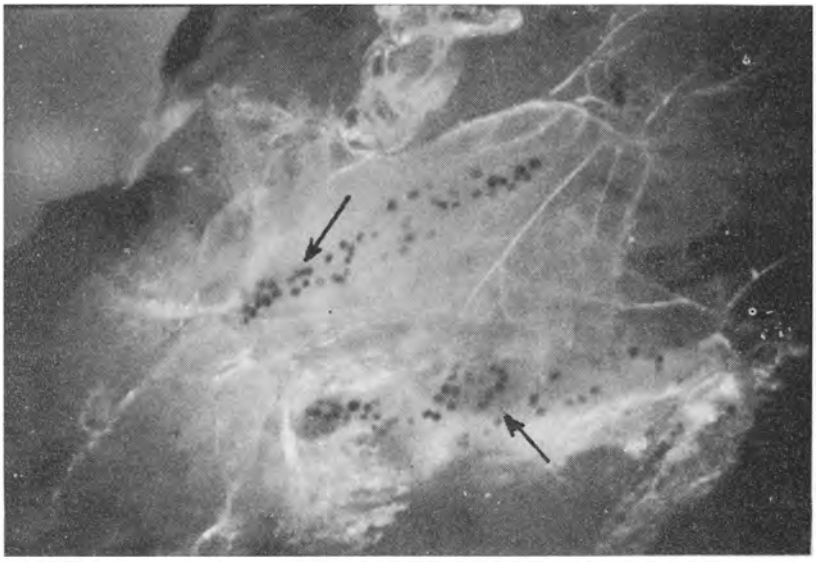

Figure 3 The arrows point to the intensely stained prothoracic gland cells of Plumbagin-treated nymph

nymphs which successfully metamorphosed possessed deformed wings (figure 2). Dissection of nymphs which were treated with doses above 5μg, revealed that the prothoracic gland cells were selectively stained blue-black (figure 3). Aorta of these nymphs also acquired bluish colour. Rectum was filled with black coloured fluid.

Discussion

Growth retardation and delay in moulting and metamorphosis caused by plumbagin treatment in lepidopterous larvae is attributed to antifeeding effect by Kubo et al. (1980). Rembold (1984) has reported that azadirachtin, an antifeedant compound brings about similar effects by disruption of neuroendocrine system in *Locusta migratoria*. Our results suggest that in the case of *D. cingulatus*, the retardation of growth and delay in metamorphosis is most likely due to interference by plumbagin with the secretory activity of prothoracic gland of this insect. Similar results were obtained with the related species of cotton bug, *D. koenigii* (Chadha et al. 1986). The above observations and the fact that nymphs in which metamorphosis is inhibited failed to develop proper second cuticle, but continue to live longer periods, suggest that plumbagin either delays or totally inhibits moulting hormone production. Morphogenetic abnormalities like deformed wings observed in the metamorphosed insects could be due to interference in the differentiation of these structures.

Ongoing experiments with other age groups of 5th instar nymphs of *Dysdercus*, have indicated that nymphs are more susceptible to plumbagin treatment when the gland is in a secretory phase (Joshi et al. 1987). Plumbagin thus can be used as a physiological tool for following the secretary activity of the prothoracic glands of susceptible insects.

Acknowledgements

Thanks are due to Professor K N Mehrotra of the Indian Agricultural Research Institute, New Delhi and to Shri V Ramakrishnan of Bio-organic Division, BARC, for useful suggestions and discussion.

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