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Repellency of two monoterpenoids and neem oil against *Callosobruchus maculatus (F.)*

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Abstract: The repellent activity of monoterpenoids viz. eugenol, zimtaldehyde and neem oil against pulse beetle, *Callosobruchus maculatus* (F.) was investigated. Responses varied significantly with compound, dose and exposure time. The tested components showed highest level of repellency against *C. maculatus* at a dose of 1 µl. Over 80%, Class V, repellency was achieved after 5 to 60 min. treatment with the components at a dose of 1 µl. The repellent action of zimtaldehyde showed the highest repellency (87.41% at 10 min exposure) status against *C. maculatus* than neem oil and eugenol, while the lowest (79.46%) was recorded for eugenol at 25 min exposure level.

Key words: Repellency, eugenol, zimtaldehyde, neem oil, *C. maculatus*

Introduction

Post-harvest insect pests, including cowpea weevil, *Callosobruchus maculatus* (F.) (Coleoptera : Bruchidae, can cause serious losses during storage, reducing the quantity and/or quality of the stored products (Evans, 1987). With the high cost of synthetic products, problems with controlling post-harvest insects include residues of applied chemicals on grains (Jessup & Sloggett, 1993), phytotoxicity and development of resistance to various groups of insecticides (Subramanyam & Hagstrum, 1996). The repellency against stored product pests has already been demonstrated for some plant essential oils and their compounds (Kim *et al*., 2003). Perillaldehyde, cinnamaldehyde, carvacrol, γ-terpinene, thymol, menthol and citrus plant derived compounds were used as a repellent against *Lasioderma serricorne* (Hori, 2003). The essential oil of *Artemisia annua* L. against *Tribolium castaneum* (Tripathi *et al*., 2000); and zimtaldehyde, eugenol and thymol against *T. confusum* (Ojimelukwe & Adler, 1999) were tested. Repellency of some 51 plant leaves were tested against *L. serricorne* by Ambadkar & Khan (1994).

Many plant extracts, essential oils, and their constituents manifest fumigant (Isman, 2006, Rajendran & Sriranjini, 2008) and/or repellent activity against some stored-product insects (Wang *et al*., 2006). Hence, the present study was undertaken to observe the repellency of three phytochemicals *i.e*. eugenol, zimtaldehyde and neem oil against *C. maculatus*.

Materials and Methods

Adults of cowpea weevil, *C. maculatus* were collected from the warehouses in the Rajshahi City, Bangladesh and reared on *Vigna radiata* in an incubator at the laboratory. Department of Zoology, Rajshahi University in September, 2007. The stock cultures were maintained at 30°C and 70-75% relative humidity. Unsexed adults of 1-2 days old were used in the experiments.

Eugenol (2-methoxy-4- [2-propenyl] phenol, 99% purity, MW=164.2), an active constituent of the clove plant, *Syzygium aromaticum* (Myrtaceae); Zimtaldehyde (3-Phenyl-2-propenal, 99% purity), an active constituent of the cinnamon plant *Cinnamomum verum* (Lauraceae) and neem oil were collected from Carl Roth GmbH and Aldrich Ltd., Berlin, Germany, and used in the present experiment.

Repellent activities of the phytochemicals against *C. maculatus* were evaluated using slight modification of the area preference method (McDonald *et al*., 1970). Test areas were designed using plastic tube each of which 11 metre long (5×5-cm dia). Eleven plastic tubes each one-metre long were taken separately. One of these tubes has an opening on the back (2×2-cm dia) and two of these tubes were closed at one side. The back opening of the tube was placed in the middle and with one-side closed two tubes were placed at the both of the end side of long tube. A filter paper (Whatman, 3.0 cm dia) treated with phytochemical was placed at the end of the one side closed tube. Another end of the tube served as control. One hundred adults of *C. maculatus* were released in the middle of each tube. Then the movement of the bruchid beetles

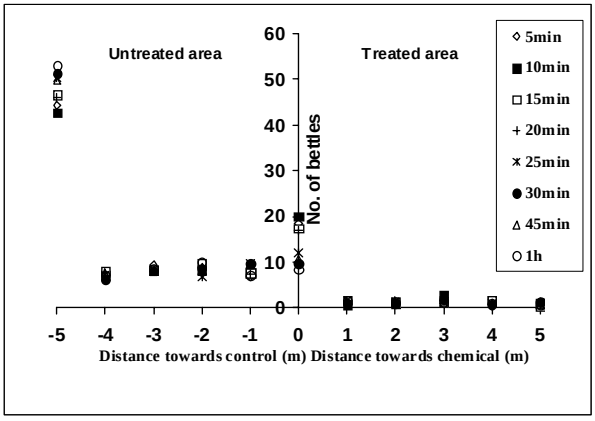
was observed. Each treatment was replicated 3 times. The numbers of beetles present on control (Nc) and treated (Nt) were recorded after 5, 10, 15, 20, 30, 45 and 60 minutes of the treatment. The percent repellency (PR) was calculated according to McDonald *et al*., (1970). One µl dose level was selected for each phytochemical used in the experiment.

Repellency data were analysed statistically as a randomized block experiment in 3 replicates and the effects of concentration on repellency were represented graphically. Mean repellency values were assigned to repellency classes (McGovern *et al*., 1977) from 0 to V, where 0 = <0.1; class 1 = 0.1-20; class II = 20.1-40; class III = 40.1-60; class IV = 60.1-80 and class V = 80.1-100% repellency.

Results and Discussion

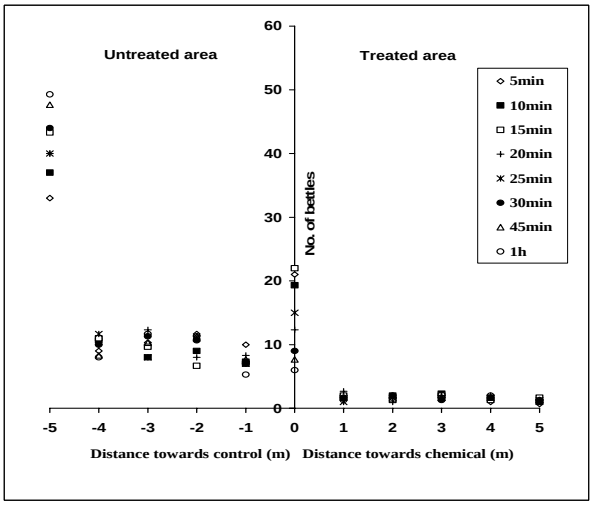
The results of repellency of eugenol against *C. maculatus* are shown in Fig. 1 (Table 1). As shown in Fig.1, 33 percent insect tended to move towards control (untreated) area at 5 min. exposure while only 0.67 percent insect moved towards eugenol treated area. It is interesting to note that the densities of insects towards the control area increased with increase of time. At one-hr exposure, 49.3 percent insect showed their movement towards the control area while only 1.3 percent insect reached the eugenol treated area. Mean repellency of 82.71 and 85.10 percent was showed after 5 and 60 min exposure, respectively (Table 1). The χ^2 values showed the highly significant (P<0.001) repellency effect for all the exposure and chemical levels. Eugenol showed class IV repellency at 10 and 20 min exposure while 5, 15, 25, 30, 45 and 60 min exposure showed class V repellency against *C. maculatus*.

The findings of repellency on zimtaldehyde against *C. maculatus* are reflected in Fig. 2, (Table 1). As shown in Fig. 2, 44.3 percent insect tended to move towards control area at 5 min exposure while only 1.3 percent insect moved towards zimtaldehyde treated area. Results also showed that the densities of insects towards the control area increased with the increasing time as shown for eugenol. At one-hr exposure, 53 percent insect showed their movement towards the control area while only 0.67 percent insect reached the zimtaldehyde treated area. Mean repellency of 86.92±0.97 and 86.92±1.18 percent was showed after 5 and 60 min. exposure respectively (Table 1). Insects were repelled in the (-) control area after 5 min exposure, among 100 insects. 87.41±1.81 and 86.92±1.18 insects were repelled after 30 and 60 min exposure respectively (Fig. 4, Table 1). The χ^2 values showed the highly significant (P<0.001) repellency effect for all the exposure and chemical levels (Table 1). Zimtaldehyde showed class V repellency status at all the exposure levels against *C. maculatus*.



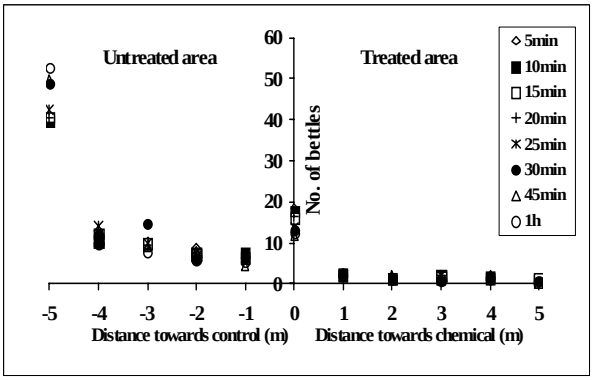
Movement of beetles

Fig. 1. Behavioural distribution pattern of *C. maculatus* treated with eugenol



Movement of beetles

Fig. 2. Behavioural distribution pattern of *C. maculatus* treated with zimtaldehyde



Movement of beetles

Fig. 3. Behavioural distribution pattern of *C. maculatus* Treated with neem oil

Table 1. Repellent effects of phytochemicals on *Callosobruchus maculatus*

Name of Compounds	Exposure (Min)	% Mean Repellency±SE	χ^2 values	Repellency Classes*
Eugenol	5	82.71±2.83	42.80	V
	10	78.41±2.20	32.28	IV
	15	80.56±4.10	37.36	V
	20	79.46±1.34	34.72	IV
	25	82.75±1.83	42.90	V
	30	82.35±2.63	41.86	V
	45	82.00±1.06	40.96	V
	60	85.10±0.16	49.28	V
Zimtaldehyde	5	86.92±0.97	54.52	V
	10	85.79±0.62	51.24	V
	15	85.45±1.13	50.27	V
	20	84.25±0.60	46.92	V
	25	86.36±0.09	52.88	V
	30	87.41±1.81	55.98	V
	45	87.30±0.65	55.65	V
	60	86.92±1.18	54.52	V
Neem oil	5	86.74±0.63	53.99	V
	10	81.41±2.01	39.46	V
	15	79.65±1.96	35.16	IV
	20	82.42±2.31	42.04	V
	25	83.76±1.49	45.58	V
	30	85.45±0.60	50.27	V
	45	84.18±1.07	46.73	V
	60	87.09±0.29	55.02	V

Repellency classes: O = < 0.1; class I = 0.1- 20; class II = 20.1- 40; class III = 40.1- 60; class IV = 60.1- 80; class V = 80.1-100 (Based on Juliana & Su, 1983).

The data on repellency of neem oil against *C. maculatus* are shown in the Fig. 3 (Table 1). Result showed that 40.67 percent insect tended to move towards control area at 5 minutes exposure while only 0 percent insect showed their movement towards neem oil treated area. Densities of insects towards the control area increase with the increased of time as observed in cases of eugenol and zimtaldehyde. At one-hr exposure 52.67 percent insect showed their movement towards the control area while 0 percent insect reached the neem oil treated area. Results also showed that 86.74 and 87.09 percent mean repellency was recorded after 5 and 60 min exposure respectively (Table. 1). The χ^2 values showed the highly significant ($P< 0.001$) repellency effect for all the exposure and chemical levels. Neem oil showed class V repellency status for all the exposure levels against *C. maculatus*, except for 15 min exposure, which showed class IV repellency status.

The three phytochemicals showed highly significant ($P<0.001$) repellency against *C. maculatus*. Results also exhibit that the zimtaldehyde was the most effective in terms of repellency effect followed by neem oil and eugenol. The present study reveals that plant derived compounds like eugenol, zimtaldehyde and neem oil repelled the adult beetles at a dose of 1 µl. These results are in agreement with the study of Hori (2003), who reported that 48 essential oils repelled the beetles at a dose of 1 µl. Repellency effects of plant-derived components were less than that of essential oils (in this study neem oil) and showed more repellency than eugenol against *C. maculatus*. This conforms to the findings of Hori (2003), who reported that the repellency of, (-) perillaldehyde, cinnamaldehyde, thymol and (-) menthol was less than ajowan oil, black pepper oil, clove oil, eucalyptus oil, fennel oil, ginger oil, lemon oil, rose oil and sage oil. In the present investigation, the mean repellency values of eugenol, zimtaldehyde and neem oil were found to be above 80% and the repellency class of eugenol showed IV & V, zimtaldehyde class V repellency whereas neem oil exhibited class IV & V repellency. Similar results were observed by Ojimelukwe & Adler (1999), who reported that the mean repellency values of eugenol and zimtaldehyde were above 80%, eugenol showed class IV repellency and zimtadehyde also exhibited class V repellency. They also mentioned that α-pinen, camphor, linalool, menthol, hydroxy-anisol, thymmol exhibited 23, 35, 42, 40, 50 and 70% repellency respectively. Furthermore, they noticed that there was considerable variation in the repellent effects of the different test materials. Hassanali *et al*. (1990) showed that eugenol was highly repellent to *Sitophilus zeamais* in a Y-shaped choice bioassay system. Obeng-Ofori & Reichmuth (1997) found eugenol to be highly repellent to *S. granarious, S. zeamais, T. castaneum* and

Prostephanus truncatus. The results of the present investigation support the findings of Wang *et al*. (2006) and Islam *et al*. (2008), who found the repellency and fumigant activity of essential oils of *Artemisia vulgaris* and *Coriandrum sativum* against *T. castaneum*. However, it could be concluded that the chemicals used to determine the repellency effect should play an important role prior to implementing of stored product protection.

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