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Gonadotrophic Effects of RH-5849, a Non-Steroidal Ecdysone Agonist on the Rice Moth *Corcyra cephalonica* St. (Lepidoptera: Galleriinae)

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Abstract--In several areas throughout the world, the eggs of the fictitious host insect, *Corcyra cephalonica*, are used to produce multiple natural enemies, such as *Trichogramma* species, which are widely utilized for biological control of lepidopterous pests on diverse crops in more than 30 nations. The purpose of this study was to determine the efficacy of RH-5849, a non-steroidal ecdysone mimic, on the gonadotrophic parameters of the rice moth, *Corcyra cephalonica*. The separated II instar larva received the compound topically on the abdomen dorsum by means of Hamilton micro syringe in acetone. Five replicates (50 insect/replicate) were used per each dosage. Similar replicates were used for the control insects without any treatment. The mean number of eggs laid by a female moth was worked out on the basis of the total number of eggs laid by ten females. In a dose-dependent way, the sterility percentage was enhanced while the hatching percentage was decreased. The sterility indices were shown to be dose-dependent, according to current data. It should not be forgotten that the hatching percentages reversed this effectuation tendency (egg viability). The egg viability rose when the RH-5849 dose was reduced, and vice versa.

Keywords--*C. cephalonica*, gonadotrophic, hatching, RH-5849, rice-moth.

Introduction

The present investigation was conducted on the rice moth, *Corcyra cephalonica* (Stainton) (Family Pyralidae, Subfamily gallerinae) which is a serious lepidopteran pest of stored cereals such as wheat, rice, sorghum, maize, millet etc. in tropical and subtropical region of the world (Krishna, 1930 and Russel et al., 1980). *Corcyra cephalonica* has a wingspan of 1.7 cm (males) to 1.9 cm (females). The wings are uniformly dark grey, sometimes streaked with darker lines along the veins. The head is snout like in females while blunter in males. It is an external feeder. The larva is initially creamy white and gradually darkens to a dirty white with a reddish brown head capsule. After completing development through five instars, it weaves a cocoon incorporating food grains, debris and other materials. The pupa is leathery brown and measures about 8 mm (Kalyanakumar et al, 2013).

The female reproductive system of *Corcyra cephalonica* consists of a pair of ovaries. Each ovary is composed of four ovarioles. Distal end of each ovariole is called germarium which is followed by the vitellarium. Vitellarium includes major portion of the ovariole in which a series of immature eggs become progressively larger. Each ovary opens into lateral oviduct (Kamel et al, 1969). The two lateral oviducts unite in a single median common oviduct. Typically, the common oviduct is heavily invested with muscles and the lateral oviduct less so. The distal end of common oviduct is called gonopore. Genital chamber modifies to form a capacious bursa copulatrix which acts as a receptacle for male intromittent organ. A pair of accessory gland is present in the reproductive system of *Corcyra cephalonica* (Kumar and Krishna, 1991).

There are on an average of 240-275 eggs in various stage of development in the ovaries of female adults of *Corcyra cephalonica*. Eggs are pearly white ellipsoids with irregularly sculpted surface and a small nipple at one end (Manjunath et al, 2013) The eggs of the factitious host insect, *Corcyra cephalonica* are used for production of several natural enemies in many countries across the world e.g. *Trichogramma* species which are used widely for the biological control of lepidopterous pests on various crops in more than 30 countries (Jalali et al., 2007). In perspective of the damage caused by *C. cephalonica*, the efficacy of RH-5849 was assayed for their gonadotropic effects. The present investigation was conducted to assess the potency of the non-steroidal ecdysone mimic, RH-5849, on the gonadotropic parameters of rice moth, *C. cephalonica*.

Materials and Methods

Treatment of the insect larvae with RH-5849

Based on the previous study (Ganji Bhagyalakshmi, 2022) on toxicity evaluation, the below LC50 (<2.20 µg/insect) was chosen as sub-lethal concentrations (i.e, 0.6, 0.12, 0.25, 0.5 and 1 µg/insect). The RH-5849 was diluted to obtain the dosages of 0.6, 0.12, 0.25, 0.5 and 1 µg/insect. The separated II instar larva received the compound topically on the abdomen dorsum by means of Hamilton micro syringe in acetone. Five replicates (50 insect/replicate) were used per each

dosage. Similar replicates were used for the control insects without any treatment.

Gonadotrophic effect (fecundity and sterility)

The normally appeared treated pupae were transferred from the breeding pans into small cages (20x20x20 cm) in order to study the reproduction. The total number of eggs laid by the female emerged from various treatments was counted. The mean number of eggs laid by a female moth was worked out on the basis of the total number of eggs laid by ten females. The data obtained were analysed statistically. After adult emergence, females only were used to estimate the fecundity and sterility index.

Effect on oviposition period

Ten females emerged from different treatments were kept separately in plastic containers. First to last egg laid was counted to record the oviposition period. The data obtained were analysed statistically.

Egg-Laying capacity and egg hatchability

For the observation of percent egg laying capacity and hatchability, the adults obtained from the experiment, were sexed just after their emergence and the males and females were kept separately in the glass containers (33 mm diameter and 200 mm height). The eggs laid were collected daily till the females die and the collected eggs were transferred to the hatching sites (Glass petridishes of 100 mm diameter and 10 mm height) and allowed to hatch. The adults emerged from experiment were immediately sexed and used for mating experiment. For this purpose, four types of crosses were made, as following:

- Treated male x Normal female
- Normal male x Treated female
- Treated male x Treated female
- Normal male x Normal female (Serving as control)

(Treated male and treated female refer to the male and female moths obtained from treated culture).

Results and Discussions

Effect on the reproductive potentiality/fecundity and sterility

The higher dose levels (0.5 and 1 $\mu\text{g}/\text{larva}$) when found as deformed. These deformed females could not lay eggs. The data regarding effect of RH-5849 on oviposition period, and hatching percentage are presented in Table 1 and Figure-1. When different doses of RH-5849 were tested, no adult emergence were observed in the treatment at 1 $\mu\text{g}/\text{larva}$ dose. Therefore, oviposition period recorded very low in these treatments, while in remaining treatments, oviposition period ranged from 2.40 to 4.05 days as against 4.28 days in untreated control. Minimum oviposition period were observed in case of eggs which were observed to

be deposited by the female moth emerged from the treatment with RH-5849 (2.4 days) at 1 µg/larva dose, 3.66 days, 3.87, and 4.05 days at 0.5, 0.25, 0.12 µg/larva dose of RH-5849 respectively. The shortest oviposition period was seen in the case of eggs deposited by the female moth after treatment with RH-5849 (2.4 days) at 1 µg/larva dose, 3.66 days, 3.87 days, and 4.05 days at 0.5, 0.25, and 0.12 µg/larva doses, respectively.

All other dosages of RH-5849, in the present study, severely suppressed the female fertility and fecundity (Figure-2). Both the egg laying capacity (fecundity) and egg hatchability (fertility) observed by the different crosses, were significantly decreased with increased concentration of RH-5849 as compared to controls ($P < 0.0001$).

The sterility percentage was increased and hatching percentage was decreased in dose dependent manner. Current data show the sterility indices were pronouncedly dose-dependent. It should be overlooked that such trend of effectuation was reversed by the hatching percentages (egg viability). The egg viability increased by the decreasing dose levels of RH-5849 and vice versa. Reviewing our results, a case had turning the attention that was the hatchability of the very few eggs oviposited by females after treatment of the pupae with 0.5 µg/pupa. These very few eggs were completely non-viable.

Table 1
Effect of the RH-5849 on the egg lying capacity and percent hatching of eggs of *C.cephalonica* exposed to 2nd instar larvae

Doses (µg/ larva)	Sets	Flies treated as pupa				
		Fertility	Fecundity	Mean oviposition period (Days)	% Hatching	% Sterility
Control	Nm x Nf	179.3± 1.54	157.4± 1.5	4.28	95.87± 0.29	2.11± 0.9
	Tm x N f	135.2± 2.21	103.7± 1.91	4.05	51.80± 0.33	35.23± 3.65
0.06	Nm X Tf	122.4± 2.34	91.3± 1.1	4.01	45.1± 0.44	39.45± 2.90
	Tm X Tf	101.8± 1.98	73.5± 1.5	3.92	41.33± 1.0	44.10± 2.08
	Tm x N f	106.3± 1.44	58.7± 2.33	3.87	48.22± 0.31	43.44± 1.40
0.12	Nm X Tf	84.33± 1.98	51.4± 1.17	3.80	42.44± 1.03	46.90± 2.09
	Tm X Tf	71.90± 1.08	38.9± 1.22	3.72	33.4± 1.33	51.04± 1.19
	Tm x N f	76.7± 1.12	23.4± 1.66	3.66	33.88± 2.44	52.01± 3.77
0.25	Nm X Tf	63.1± 1.3	11.0± 1.09	3.60	28.44± 1.03	55.9± 2.10
	Tm X Tf	52.4±	4.41±	3.10	20.41±	59.30±

		1.99	0.14		0.33	2.33
	Tm x N	45.0 _±	3.21 _±	2.40	22.65 _±	61.89 _±
	f	1.0	0.01		1.66	4.22
0.5	Nm X Tf	32.4 _±	2.80 _±	2.21	18.90 _±	65.0 _±
		1.40	0.17		1.00	2.40
	Tm X Tf	11.5 _±	1.19 _±	1.01	15.3 _±	69.0 _±
		1.08	0.01		0.33	1.10
	Tm x N	35.1 _±	2.02 _±	1.84	10.04 _±	68.4 _±
	f	1.3	0.04		0.12	2.09
1	Nm X Tf	21.0 _±	1.01 _±	1.28	7.44 _±	71.0 _±
		2.08	0.08		0.50	2.44
	Tm X Tf	15.2 _±	1.00 _±	0.60	3.10 _±	77.40 _±
		1.04	0.03		0.10	3.29

Values has been expressed as mean±SD of six replicates

Values are significantly different ($p < 0.0001$) from their control when t-test was applied.

Tm x N f = Treated male x Normal female; Nm X Tf = Normal male x Treated female; Tm X Tf = Treated male x treated female.

When a normal female was crossed with a male treated with RH-5849 at a dose level of 0.025 $\mu\text{g}/\text{larva}$, the female's fertility and fecundity were 135.2_±2.21 and 103.7_±1.91, respectively, which were reduced to 45.0_±1.0 and 3.21_±0.01 at 0.5 $\mu\text{g}/\text{larva}$.

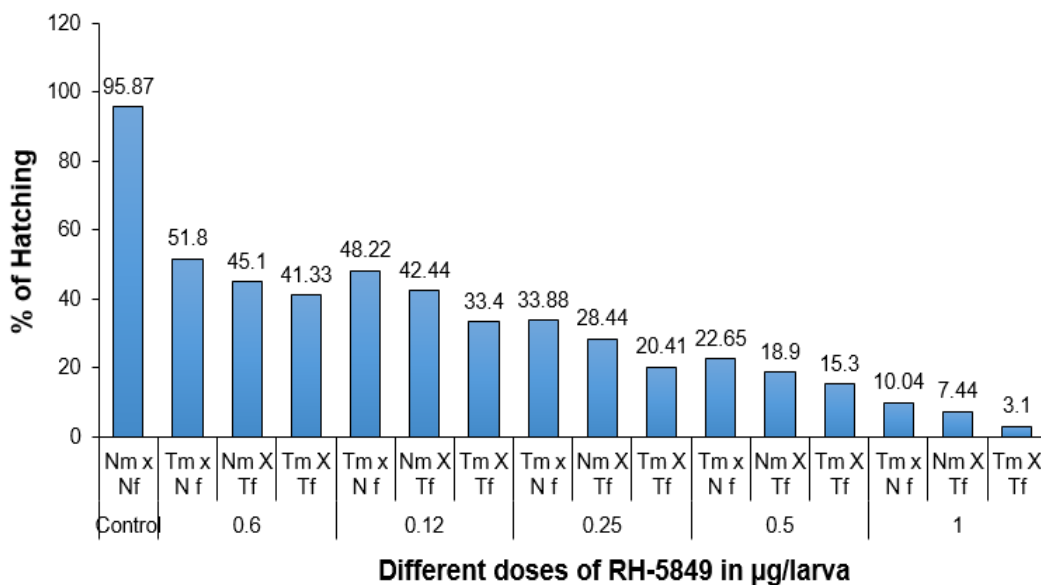


Figure 1. Effect of the RH-5849 on the percentage of hatching of flies treated as pupa of *Corcyra cephalonica* exposed to III instar larvae

For the same parameters such as fertility and fecundity, the findings obtained from crosses between normal male and treated female at 0.025 $\mu\text{g}/\text{larva}$ dose level of RH-5849 were 122.4_±2.34 and 91.3_±1.1, respectively, which were reduced to 32.4_±1.40 and 2.80_±0.17 at 0.5 $\mu\text{g}/\text{larva}$.

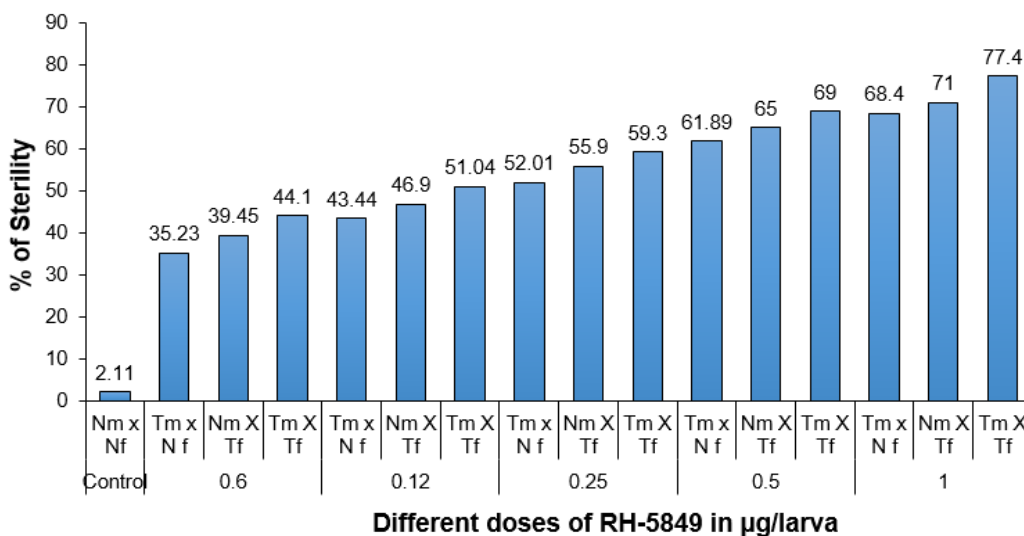


Figure 2. Effect of the RH-5849 on the percentage of sterility of flies treated as pupa of *Corcyra cephalonica* exposed to III instar larvae

When both the male and female were treated with 1 µg/larva concentrations of RH-5849, fecundity and fertility were 101.8 ± 1.98 and 73.5 ± 1.5 , respectively, but were reduced to 11.5 ± 1.08 and 1.19 ± 0.01 at 0.5 µg/larva. When both sexes of a pair were treated, the data in table 1 shows that fecundity and fertility were low. However, when only the female of the pair was treated, the rate of fecundity and fertility reduced compared to when only the male of the pair was treated. It is considered that at least one of the pair's treated adults, either male or female, is responsible for the pair's reduced fecundity and fertility.

The findings of this study correspond with those of Sawant (2001), who noted that no eggs were laid in insecticide treatments, hence no incubation period was recorded. The effect of RH-5849 on percent hatching was 95.87 ± 0.29 in this study, compared to 95.87 ± 0.29 in the untreated control. The findings are comparable to those of Patkar (1990), who found that the sweet flag produced the least number of eggs at a 6 percent level, followed by soapnut shell and black pepper at a 6 percent level w/w. In a mixed application, Sawant (2001) found that neem leaf powder used at 5 g, 4 g, and 3 g per 100 g of seed (49.38, 56.25, and 63.75 percent) had the least hatching, followed by neem leaves, citrus rind powder used at 5 g per 100 g of seed (72.5 percent). According to Jadhav (2013), the treatment with sweet flag powder was more effective, with just 50% of the eggs hatching. In this study, the impact of RH-5849 against *C. cephalonica* yielded the same findings.

Conclusion

On the basis of the findings, it can be concluded that RH-5849 has a negative impact on the fecundity and fertility of the rice moth *Corcyra cephalonica*, a major pest of stored cereal commodities. Of course, it could be used as a safer

alternative to conventional insecticides for the effective control of *Corcyra cephalonica* and other lepidopterous pests in general.

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