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Effect of maleic hydrazide on the biology of melon fly, *Bactrocera cucurbitae*, Coquilett (Diptera: Tephritidae)

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Abstract
The family cucurbitaceae includes a large group of plants which are medicinally valuable. The melon fly, *Bactrocera cucurbitae* are the most serious damage to many cucurbitaceous crops. Different concentrations of Maleic Hydrazide (MH) were taken on the biology of *B. cucurbitae*, which showed gradual increase in the weight of pupa and the pupal duration with the increase in the concentration of MH. The adult emergence was minimum (54.55%) at 1000 ppm MH. The oviposition period was longest (15.66 days) at 10 ppm MH which gradually decreased to 2.6 days at highest concentration of MH (1000 ppm). The insect laid maximum (336 eggs/female) at 10 ppm which gradually decreased with increase in MH concentration and was minimum (15 eggs/female) at 1000 ppm MH. The minimum incubation period was 19.66 hours at 10 ppm which gradually increased to (30 hours) at 1000 ppm MH. The shortest adult longevity of insect was observed at 1000 ppm MH which was 27.00 days for male and 29.00 days for female.

Keywords: *Bactrocera cucurbitae*, maleic hydrazide, oviposition, incubation period and adult longevity

Introduction
The cucurbitaceae family ranks among the highest of plant families for number and percentage of species used as human food. The fruits are mainly attacked in early stages and fail to develop properly and drop or rot on the plant. Since the insects damage the fruits internally, it is difficult to control by insecticides. The extend of losses vary between 30 to 100% depending on the cucurbits species and season and successfully breeds when the temperature is 32.2ºC and RH between 60 to 70% respectively.
(Robinson, 1960) [8] Reported on the adverse effects of the plant growth retardant Maleic Hydrazide (MH) on the fecundity of the pea aphid. (Yule *et al*. 1966) [14] Also found a reduced fecundity in pea aphids reared on broad bean plants which had been treated with MH. They postulated that the aphid fecundity was due indirectly to nutritional deficiencies in the growth-retarded plants, rather than directly to MH or its metabolites.
The growth regulatory compounds of the plants, directly or indirectly are bound to play important role in the pattern of growth and reproduction of associated phytophagous insects (Kaur and Rup, 2002) [5]. Therefore, there is need to find the alternative methods of control and develop an integrated control for the management of this insect. The aim of the present work was to regulate the plant growth regulators Maleic hydrazide on the life history of insects.

Materials and methods
Investigation on the effect of MH on the growth and development of melon fruit fly, *Bactrocera cucurbitae* was conducted in the laboratory, Department of Entomology, College of Agriculture, Central Agricultural University, Imphal during 2016 in completely randomized design (CRD) with 3 replications. Infested fruits of cucumber were collected from the field and kept in 20×20×8 cm plastic trays on a 5 cm thick layer of sieved sterilized sand to facilitate pupation. The newly emerged adult flies were placed inside the rearing cages 35× 30× 35cm which had wire mesh on 3 sides and one door of wire mesh on one side. The flies were provided with water + honey + protein hydrolysate (9:0.5:0.5) as food kept in a 50 ml beaker Slices of cucumber were kept inside the cage for oviposition and were replaced by fresh ones daily to avoid decay.

The eggs laid on cucumber slices were collected and placed in 10 cm diameter petri dishes and after egg hatching, fresh cucumber slices were kept in petri dish for feeding the young larvae.

The larvae (3rd instar) of the insect were maintained and MH was procured from Loba Chemic Pvt. Ltd, Mumbai. Various six concentrations of MH (10, 50, 100, 200, 500, and 1000 ppm) were prepared. Third instar larvae were dipped in each concentration of the solutions of MH in a petriplate (10 cm dia) for a period of 1 minute and treated maggots were transferred to a petri plate (10 cm dia.) containing 2 cm thick layer of sterilized and sieved sand for pupation after 3- 4 days. The pupas were kept for adult emergence and record on pupal duration was noted. One male and one female adult fly were released in a glass jar covered with a piece of nylon net. A slice of cucumber was provided for oviposition after 7 days of release of adult and was replaced by fresh one daily. The number of eggs laid on each cucumber slices were counted under a stereoscopic zoom binocular microscope. Following observations were recorded: Incubation period, Fecundity/female, Total larval period, Pupal period, Size of mature larvae, Size of pupa, Sex ratio, Adult longevity.

Results and Discussion

Effect of MH on pupal size, pupal weight, pupal duration and adult emergence and sex ratio of *B. cucurbitae* are depicted in (Table 1). The increase in the weight of pupa was 15.50 mg at 50 ppm which increased to 18.25 mg at 1000 ppm. The length of pupa was from 5.7 mm to 6.25 mm in the different concentrations of MH and pupal breadth ranged from 2.42 to 2.61 mm. The pupal period also showed significant difference among the different concentration. The minimum pupal duration was obtained at 100 ppm MH (8 days) while the maximum duration was 9.83 days at 1000 ppm MH. The adult emergence was minimum (54.55%) at 1000 ppm MH. The sex ratio did not sowed significant difference among the various concentrations of MH. Similarly, (Aylin and Mehmet 2015) [1] also obtained increase in pupal duration of *Galleria mellonella with* the increase in the concentration of abscisic acid. (Kaur and Kaur 2013) [4] Also reported decrease in the adult emergence of *S. litura* at higher concentration of coumarin in comparison to higher adult emergence in control.

Table 1: Effect of MH on pupal size, pupal weight, pupal duration, adult emergence and sex ratio of *B. cucurbitae.*

Maleic hydrazide (ppm)	Pupal weight (mg)	Pupal size (mm)		Pupal period (days)	% Adult emergence	Sex ratio (Male: Female)
		Length	Breadth			
10	15.52	5.70	2.56	8.10	95.65 (84.37)	1:1.23
50	15.50	5.80	2.51	8.16	93.30 (80.89)	1:1.21
100	15.91	6.15	2.61	8.00	89.96 (71.89)	1:1.45
200	16.06	6.15	2.50	8.30	77.73 (61.67)	1:1.66
500	17.80	6.25	2.42	9.33	75.50 (59.71)	1:1.30
1000	18.25	5.76	2.45	9.83	66.63 (54.55)	1:1.05
Control	15.26	5.85	2.45	8.00	97.77 (85.63)	1:1.70
S.E.(d)	0.31	0.12	0.11	0.31	8.38	0.38
C.D(p= 0.05)	0.67	NS	NS	0.67	17.93	NS

Means followed by different letters are significantly different at 5% level
Data are mean of three replications (10 individual per replication)
Means are separated by LSD test

Effect of MH on pre oviposition, oviposition and post oviposition period of *B. cucurbitae* are presented in (Table 2). The pre oviposition period of the insect was 18.3 days at 10 ppm which gradually increased and was maximum (25.6 days) at 1000 ppm MH. Similarly, the oviposition period was longest 15.66 days at 10 ppm MH which gradually decreased to 2.6 days at highest concentration of MH (1000 ppm). The post oviposition period of the insect was 4.60 days at 10 ppm which gradually decreased to 1.30 days at 1000 ppm. (Kaur and Rup 2002) [5] Also reported shortening of longevity and oviposition period of melon flies drastically with the treatments of kinetin, coumarin, GA_3 and IAA which corroborates the present finding.

Table 2: Effect of MH on pre oviposition, oviposition and post oviposition period of *B. cucurbitae.*

Maleic hydrazide (ppm)	Pre-oviposition period (days)	Oviposition period (days)	Post-oviposition period (days)
10	18.30	15.66	4.60
50	19.30	14.00	4.30
100	23.00	12.00	5.30
200	24.60	11.30	1.60
500	24.30	4.30	1.30
1000	25.60	2.60	1.30
Control	17.60	32.33	6.60
S.E.(d)	1.15	1.73	0.89
C.D (p= 0.05)	2.46	3.70	1.90

Data are mean of three replications (10 individual per replication)
Means followed by different letters are significantly different at 5% level
Means are separated by LSD test.

Effect of Maleic hydrazide on the fecundity, number of days eggs laid and incubation period of *B. cucurbitae* are depicted in (Table 3). The insect laid maximum egg (336 egg/female) at 10 ppm which gradually decreased with increase in MH concentration and was minimum (15 eggs/female) at 1000 ppm MH. Similarly, the number of days eggs laid was maximum (15.3 days) at 10 ppm MH which gradually showed decrease with the increase in MH concentration being

minimum (2.3 days) at 1000 ppm. The different concentration of MH also showed significant effect on the incubation period. The minimum incubation period was (19.66 hours) at 10 ppm which gradually increased with increase in MH concentration and was maximum (30 hours) at 1000 ppm MH. Similarly, a reduction in the reproductive potential following the application of PGR kinetin has been reported in *Aphis fabae* (Scheurer and Aschermann, 1974) [10] and *Zaprionus paravittiger* (Sharma *et al.*, 1997) [11]. Studies on *Drosophila melanogaster* (Nakazima and Kawazu, 1980), *Sitotroga cerealella* (Pandey and Teotia, 1980) [7], *Aphis craccivora* (Mansour *et al.*, 1982) [6] and *Lipaphis erysimi* (Rup *et al.*, 1998) [9] also demontstrated a significant reduction in the reproductive following coumarin treatment.

Table 3: Effect of MH on the fecundity, number of days eggs laid and incubation period of *B. cucurbitae.*

Maleic Hydrazide (ppm)	Fecundity (No. of eggs/female)	No. of days eggs laid	Incubation period (hrs)
10	336.00	15.30	19.66
50	263.300	14.30	21.66
100	222.00	14.00	21.00
200	143.60	11.00	24.00
500	67.33	4.60	27.00
1000	15.00	2.30	30.00
control	586.66	17.60	21.33
S.E.(d)	31.77	1.29	2.07
C.D (p=0.05)	67.98	2.76	4.42

Data are mean of three replications (10 individual per replication)
Means followed by different letters are significantly different at 5% level
Means are separated by LSD test.

Effect of Maleic hydrazide on the size of egg and larval instar *B. cucurbitae* are presented in (Table 4). The length of egg of ranged from 1.28 mm to 1.38 mm in the different concentration of MH in comparison to 1.36 in control. Similarly, the size of first and second instar larva did not show any significant difference. The third instar larva shows significant difference among the various concentrations. The length of third instar larva was 9.48 mm to 9.83 mm in various concentration of MH in comparison to 9.86 mm in control.

Table 4: Effect of MH on the size of egg and larval instars of *B. cucurbitae.*

Maleic Hydrazide (ppm)	Egg size (mm)		Larval size(mm)					
			I instar		II instar		III instar	
	length	breadth	length	breadth	length	breadth	length	breadth
10	1.38	0.31	1.30	0.28	5.15	1.1	9.50	2.16
50	1.28	0.3	1.28	0.28	5.11	1.08	9.74	2.18
100	1.33	0.31	1.28	0.26	5.11	1.06	9.60	2.08
200	1.28	0.33	1.30	0.28	5.11	1.08	9.83	2.11
500	1.36	0.31	1.35	0.25	5.16	1.11	9.61	2.15
1000	1.38	0.31	1.30	0.3	5.18	1.13	9.48	2.21
control	1.36	0.35	1.28	0.28	5.13	1.06	9.86	2.23
S.E.(d)	0.04	0.01	0.03	0.03	0.08	0.02	0.11	0.025
C.D (p=0.05)	NS	NS	NS	NS	NS	NS	0.25	0.05

Data are mean of three replications (10 individual per replication)
Means followed by different letters are significantly different at 5% level
Means are separated by LSD test.

Effect of MH on the larval duration and adult longevity of *B. cucurbitae* are depicted in (Table 5). The longevity of male (27 days) and female (29 days) was shortest at 1000 ppm MH and the longevity gradually decreased with the increased in the MH concentration which was maximum (38.6 days) at 10 ppm of MH for females. In contrast the longevity of male (37.3 days) and female (57 days) was considerably longer in the untreated control. The duration of the first instar larvae varied from 0.72 to 0.84 days and maximum duration was observed (0.84 days) at 500 ppm and the minimum duration was (0.72 days) at 10 ppm. The duration of second instar larvae was maximum (1.87 days) at 100 and 500 ppm and the minimum duration was (1.78 days) at 10 ppm. The maximum duration was observed (2.77 days) at 50 ppm and the minimum duration was (2.57 days) at 10 ppm.

The adverse influence of GA_3 on adult longevity has been observed in *G. mellonella* (Uckan *et al.*, 2011) [12], *C. capitata* (Barbouche, 1986) [2], and *S. littoralis* (Kaur and Rup, 2002) [5]. Similar reductions in the adult longevity have also been observed in parasitoid wasps when treated with IAA and GA_3 (Uckan *et al.*, 2008) [13], which corroborates the present finding. Similarly, (Gupta *et al.*, 2009) [3] reported that GA_3 siapton caused an increase in the larval period of hairy caterpillar, *S. obliqua* at higher doses.

Table 5: Effect of MH on the larval duration and the adult longevity of *B. cucurbitae.*

Maleic hydrazide (ppm)	Larval duration (days)			Total larval duration (days)	Adult longevity (days)	
	I instar	II instar	III instar		Male	female
10	0.72	1.78	2.57	5.10	33.00	38.60
50	0.74	1.83	2.77	5.30	32.00	37.60
100	0.82	1.87	2.69	5.35	35.33	40.33
200	0.80	1.81	2.55	5.17	34.66	37.60
500	0.84	1.87	2.49	5.28	30.30	30.00
1000	0.81	1.88	2.36	5.04	27.00	29.00
control	0.89	1.92	2.74	5.58	37.30	57.00
S.E.(d)	0.02	0.02	0.02	0.04	2.03	2.44
C.D (p=0.05)	0.05	0.05	0.05	0.09	4.34	5.22

Data are mean of three replications (10 individual per replication)
Means followed by different letters are significantly different at 5% level
Means are separated by LSD test.

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