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OVICIDAL EFFECTS OF SOME JUVENOIDS ON THE SUNNHEMP MOTH, *Utetheisa pulchella* L.

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Six juvenoids viz. HS-103, Ro-10-3108, AI3-34601a, AI3-34853, AI3-35477 and AI3-70033b were tested for ovicidal effects on 1, 6, 12, 24, 48, and 60 hour old eggs of *Utetheisa pulchella* L with 1, 10, 100, 1000 and 10000 ppm concentration. All the tested compounds revealed a negative correlation in ovicidal activity with the advancing age of eggs and a positive correlation with the rise in concentration. Eggs of younger ages were sensitive and susceptibility declined sharply in 24 hour old eggs leading to further ineffectiveness in much older eggs. Among the tested compounds, Ro-10-3108 depicted the highest inhibitory effect on hatching.

Application of JH active compounds to eggs have been reported to inhibit the hatching in many Lepidopteran pests (Macfarlane and Jameson, 1974; Matolin and Gelbic, 1975 and Pallos *et al.*, 1976). It was reported that the dose and age of the eggs at the time of application of such compounds greatly modifies the overall performance of the treatment and hence, it is vital to carry out critical studies with individual species. Sunnhemp moth, *Utetheisa pulchella* L. which is an important pest of sunnhemp (*Crotolaria juncea*), oviposits on the exposed plant surfaces and thus is more vulnerable to chemicals exhibiting ovicidal properties. It was, therefore, considered pertinent to test the ovicidal effects of certain juvenoids against this pest.

MATERIAL AND METHODS

Feral adult moths were mass reared in muslin covered glass jars (30 × 20 cm) containing moist sand in the bottom to maintain adequate humidity. They were fed with 5% glucose solution. Fluted filter paper stripes were suspended in the chamber for oviposition. In order to obtain eggs for ovicidal assays newly emerged adults were retained in copulating Jars for two days before transferring them to the oviposition chambers. The oviposition chambers were periodically examined to collect the eggs with known age. The ovipositing moths were then released into new chambers. The rearing of moths and ovicidal tests were carried out under ambient laboratory conditions where the minimum and maximum temperatures ranged between 19.9° to 26.8° C and 28.1° C to 36.1° C, respectively. The compounds (Table 1) used in these studies were dissolved in the acetone to prepare the test solutions. Ovicidal tests were conducted on 1, 6, 12, 24, 48, and 60 hours old eggs with 1, 10, 100, 1000, 10000 ppm concentrations. The eggs glued in batches of 25 on 15 × 8mm adhesive papers were dipped into the test solution for five

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seconds. Four replicates were taken for each age with different concentrations. The treated eggs were allowed to dry and then transferred into the petridishes on moist filter paper to prevent desiccation. Controls treated with the solvent alone were observed along with the tested compound. The number of hatched eggs were recorded 12 hours after the normal hatching period. All the data on per cent inhibition of hatching were corrected for the non-hatchability due to any mortality or abnormality in controls by Abbott's formula (Abbott, 1925).

Table 1 : List of compounds tested for ovicidal effects against *U. Pulchella*

Code No.	Empirical formula	and chemical name	Source
HS-103	$C_{17}H_{26}ON$	6-Ethyl-3-pyridyl-geranyl ether	Dr. P. E. Letchworth Stauffer Chemical Co., California, USA.
RO-10-3108	$C_{20}H_{32}O_2$	Mixture of 6,7-Epoxy-3-ethyl-(p-ethylphenoxy)-7 methyl-nonane + 6,7-Epoxy-1-(P-ethylphenoxy)-3,4,7-trimethyl-nonane (isomeric mixture)	Dr. R. Magg Ltd., Chemical works. Switzerland
A13-34601a	$C_{18}H_{24}O_4$	Benzene,4-(6,7-Expoxy-3,7-dimethyl-2-noneyl)oxy)-1,2-(methylenedioxy)	Dr. T. P. McGovern Chemical Synthesis Laboratory, USDA, Beltsville, USA.
A13-34853	$C_{19}H_{28}O_2$	2-Nonane, 6,7-Expoxy-1(p-ethylphenoxy)-3,7-dimethyl	Dr. T. P. McGovern
A13-35477	$C_{20}H_{32}O_2$	2-Octene, 7-Ethoxy-1-(p-ethylphenoxy)-3,7-Ethoxyl	Dr. T. P. McGovern
A13-70033b	$C_{17}H_{22}O_4$	Benzene, 4-(6,7-Epoxy-3,7-dimethyl-2-Octenyl)oxy)-1,2- (methylenedioxy)	Dr. T. P. McGovern

RESULTS AND DISCUSSION

All the six compounds evaluated showed ovicidal effect against *U. pulchella* and the inhibition of hatching juvenoids was dependent both on the dose of the juvenoid and the age of eggs at the time of application (Tables 2-5). The activity of the compound was positively correlated with the increasing concentration. All the compounds were most effective when applied within an hour of oviposition and the ovicidal activity decreased as the application of juvenoid was delayed. As much as 25 to 70 per cent reduction in effectiveness was noted with 100, 1000 and 10000 ppm doses when one hour and one day old treated egg hatchings were compared. Application of juvenoids to two day old eggs was of no practical value as more than 65 per cent eggs hatched when treated even at comparatively higher dose (1000 ppm).

Table 2 : Compound R_0 - 10 - 3108

Age (Hr.)	Average inhibited hatching percentage for various concentrations in ppm					Mean of various ages
	1	10	100	1000	10000	
1	*(25.78)	(43.48)	(62.72)	(75.66)	(90.00)	(59.53)
	18.9	47.3	79.0	93.9	100.0	74.3
6	(25.47)	(43.51)	(61.57)	(75.79)	(87.08)	(58.66)
	18.5	47.4	73.3	94.0	99.7	73.0
12	(23.10)	(38.12)	(55.59)	(71.32)	(84.16)	(54.45)
	15.4	38.1	68.1	89.7	99.0	66.2
24	(4.98)	(25.91)	(36.46)	(49.93)	(59.81)	(35.42)
	0.8	19.1	35.3	58.6	74.7	33.6
48	(0.00)	(5.77)	(28.64)	(36.26)	(46.72)	(23.48)
	0.0	1.0	23.0	35.0	53.0	15.9
60	(0.00)	(2.88)	(26.51)	(33.20)	(44.42)	(21.40)
	0.0	0.3	19.9	30.0	49.0	13.3
Mean of	(13.22)	(26.61)	(45.25)	(57.02)	(68.70)	
various concs.	5.2	20.1	50.4	70.4	86.8	

* Transformed values.

S. Em. for age = 0.69 C. D. at 5% = 1.95

S. Em. for conc. = 0.63 C. D. at 5% = 1.78

S. Em. for age x conc. = 1.5 C. D. at 5% = 4.36

Table 3 : Compound A 13 - 34601a

Age (Hr.)	Average inhibited hatching percentage for various concentrations in ppm					Mean of various ages
	1	10	100	1000	10000	
1	*(24.99)	(41.66)	(59.18)	(71.18)	(87.04)	(56.81)
	17.8	44.2	73.7	89.6	99.7	70.0
6	(22.11)	(39.23)	(57.10)	(73.25)	(90.00)	(56.34)
	14.2	40.0	70.5	91.7	100.0	69.3
12	(20.56)	(36.50)	(52.85)	(67.59)	(78.84)	(51.27)
	12.3	35.4	63.5	85.5	96.3	60.8
24	(6.09)	(23.81)	(34.20)	(44.98)	(55.18)	(32.85)
	1.1	16.3	31.6	49.9	67.4	29.4
48	(2.49)	(0.00)	(23.71	(32.76	(42.98)	(20.38)
	0.2	0 0	16.2	29.3	46.5	12.1
60	(0.00)	(0.00)	(23.75)	(31.92)	(42.12)	(19.50)
	0.0	0.0	16.2	28.0	45.0	11.1
Mean of	(22.71)	(23.53)	(41.75)	(53.61)	(66.02)	
various concs.	4.8	15.9	44.3	64.3	83.5	

* Transformed values

S. Em. for age = 0 64 C. D. at 5% = 1.81

S. Em. for conc, = 0.58 C. D. at 5% = 1.65

S. Em. for age x conc. = 1.44 C. D. at 5% = 4.04

Table 4 : Compound A13-34853

Age Hr.	Average inhibited hatching percentage for various concentrations in ppm					Mean of
	1	10	100	1000	10000	various ages
1	*(24.02)	(40.81)	(59.32)	(73.55)	(84.08)	(56.36)
	16.6	42.7	74.0	92.0	98.9	69.3
6	(23.33)	(37.98)	(55.16)	(70.20)	(81.13)	(56.56)
	15.7	37.8	67.4	88.5	97.6	64.7
12	(16.48)	(34.16)	(52.00)	(68.36)	(75.66)	(49.33)
	8.0	31.5	62.1	86.4	93.9	57.5
24	(4.06)	(23.02)	(32.28)	(46.14)	(56.40)	(32.38)
	0.5	15.3	28.5	53.7	69.4	28.7
48	(2.49)	(4.98)	(22.08)	(30.14)	(38.87)	(19.71)
	0.2	0.7	14.1	25.2	39.4	11.4
60	(0.00)	(00.00)	(21.10)	(29.98)	(38.05)	(17.83)
	0.0	0.0	13.0	25.0	38.0	9.4
Mean of	(11.73)	(23.49)	(40.32)	(53.06)	(62.36)	
various concs.	4.1	15.9	41.9	63.9	78.5	

* Transformed values

S. Em. for age = 0.63 C. D. at 5% = 1.78

S. Em. for conc. = 0.58 C. D. at 5% = 1.63

S. Em. for age x conc. = 1.42 C. D. at 5% = 3.99

Table 5 : Compound A13-35477

Age (Hr.)	Average inhibited hatching percentage for various concentrations in ppm					Mean of
	1	10	100	1000	10000	various ages
1	*(15.20)	(29.11)	(46.52)	(62.80)	(75.66)	(45.86)
	6.9	23.7	52.6	79.1	93.9	51.5
6	(11.49)	(26.72)	43.16	(61.80)	(73.18)	(43.27)
	4.0	20.2	46.8	77.7	91.6	47.0
12	(15.00)	(25.73)	(37.35)	(50.78)	(61.94)	(38.16)
	6.7	18.8	36.8	60.0	77.9	38.2
24	(6.10)	(19.53)	(26.82)	(33.54)	(41.93)	(25.58)
	1.1	11.2	20.4	30.5	44.6	18.6
48	(2.49)	(4.98)	(15.45)	(22.08)	(29.47)	(14.89)
	0.2	0.8	7.1	14.1	24.2	6.6
60	(0.00)	(0.00)	(15.21)	(22.75)	(27.95)	(13.18)
	0.0	0.0	6.9	14.9	22.0	5.2
Mean of	(8.38)	(17.68)	(30.75)	(42.29)	(51.69)	
various concs.	2.1	9.2	26.1	45.3	61.6	

* Transformed values.

S. Em. for age = 0.53 C. D. at 5% = 1.50

S. Em. for conc. = 0.48 C. D. at 5% = 1.36

S. Em. for age x conc. = 1.19 C. D. at 5% = 3.34

The relative ovicidal potency of compounds could be adjudged by comparison of per cent inhibition of hatching at similar doses applied to eggs of the same age. None of the six compounds tested showed very high ovicidal activity as the doses required for 50 per cent inhibition of eggs (comparable with ED 50) were higher than 10 ppm for all the compounus when applied at the most susceptible age (1 hour). Three juvenoids viz. Ro-10-3108, AI3-34601a and AI3-34853 were moderately effective showing over 65 and 85 per cent inhibition of hatching at 100 and 1000 ppm doses, respectively, when eggs were treated within six hours of oviposition. The inhibition of hatching observed at 1000 ppm doses of these compounds were about 85, 50 and 30 per cent with 12, 24 and 60 hours old eggs, respectively. The highest dose (10000 ppm) of these compounds to 60 hour old eggs gave over 35 per cent inhibition in hatching.

The remaining compounds (HS-103, AI3-35477 and AI-70033b) were relatively less effective which gave less than 65 per cent inhibition of hatching with one hour old eggs at 100 ppm and 1000 ppm doses, respectively. Treating one day old eggs with these compounds at 1000 ppm dose resulted in more than 50 per cent normal hatching but older eggs (48 hours) showed poor activity (less than 35 per cent inhibition even at the highest dose of 10000 ppm).

The inhibitory effect on the hatching eggs by the tested compounds based on overall performance with different doses applied to eggs of varied ages revealed their efficacy in the decreasing order of merit as RO-10-3108, AI3-34601a, AI3-34853, HS-103, AI3-35477 and AI3-70033b.

Table 6 : Comparative effectiveness of compounds

Sl. No.	Compound	Mean inhibited hatching percentage for all ages and concentrations
1	HS-103	35.41
2	RO-10-3108	42.16
3	A13-34601a	39.54
4	A13-34853	38.19
5	A13-35477	30.16
6	A13-70033b	28.15

S. Em $\pm$ 0.57
C. D. at 5% 1.60

Age of the egg and the dose are two important contributing components which influence the hatchability of eggs. Slama and Williams (1966) were the pioneers to show that application of 'Juvabion' prevented 96.0 per cent hatching in freshly laid eggs of *Pyrrhocoris apterus* but one and two days old eggs were less affected and four day old eggs very virtually insensitive. During the present investigations all the tested compounds

showed increasing hatchability with the ageing of eggs. Similar trend was observed by Matolin and Gelbic (1975) and Pallos *et al.* (1976) on the eggs of *Hyalophora cecropia* and *Antheraea pernyi, Epilachna varivestis, H. cecropia, Cydia pomonella Trogoderma granarium. C. molesta, Estigmene acrea,* and *C. pomonella,* respectively. Therefore, this discussion obviously emphasises that the results of many workers with different insect species despite using somewhat diversified techniques are in general agreement with the present findings. The present observations suggest that concentration of a compound has a paramount influence on the hatching of eggs of *U. pulchella.*

The six juvenoids tested by the author demonstrated ovicidal activities in varying degrees. In the present investigation on the compound RO-10-3108 has depicted a ten-fold preponderance in ovicidal activity over compound AI3-70033b. For instance, the hatchability recorded for one hour old eggs with compound Ro-10-3108 was 81.0 52.7, 21.0 and 6.1 per cent at 1, 10, 100 and 1000 concentrations respectively, whereas, with compound AI3-70033b the hatchability at 10, 100, 1000 and 10000 ppm concentrations was 78.2, 47.9, 26.0 and 8.0 per cent, respectively. It is difficult to draw a common denominator to compare the relative effectiveness among tested insects due to different experimental conditions employed, species involved and the compounds used by different workers. However, the present results corroborate with the general trend of variable effectiveness of different compounds.

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