原　著

The Effect of Hempa on the Sterility and Longevity of Normal and DDT Resistant Strains of *Musca domestica Nebulo* Fabr. Musharraf A. Ansari and Nawab H. Khan (Zoology Department, Muslim University, Aligarh, India.) Received February 8, 1971. *Botyu-Kagaku* 36, 37 (1971).

7. DDT 感受性および抵抗性イエバエの不妊と寿命におよぼす hempa の影響 Musharraf A. Ansari and Nawab H. Khan (Zoology Department, Muslim University, Aligarh, India) 46. 2. 8. 受理

非アルキル化剤である hempa を用いて，イエバエ (*Musca domestica nebulo*) の DDT 抵抗性，非抵抗性品種について，不妊化，寿命への影響を調べた。その結果 hempa は，産卵期と卵の生存率に影響を与えることがわかった。雌雄ともに不妊化されるが，特に卵のふ化率からみると，雄により効果的である。しかし，4％の hempa では，雌も完全に不妊化され，産卵期も短縮され，産卵したものは産卵しないものより寿命が長かった。

The use of insects to control their own population has been a subject of research during the past decade and a number of chemicals liable to induce sexual sterility in the housefly *Musca domestica* have been evaluated for this purpose.[1,2] Chang *et al.*[3] found that the non alkylating agent, hempa could produce sterility in *M. domestica* while Fye *et al.*[4] obtained 100.0 % sterility in houseflies when hempa was given in the food of adults at a concenteration of 0.05 %. Similar results were obtained by Labrecque *et al.* (1966) when hempa was applied to the pupae and adults of houseflies.[5]

The effect of chemosterilants on the longevity of insect has been studied by Murvosh *et al.*[6] who conducted experiments to determine the effects of metepa and apholate on the longevity of flies and observed that these chemicals substantially shortened the life span of the fly. The longevity of *Popillia japonica* was also reduced when treated with apholate[7]. Raghuwanshi and his associates observed a considerable reduction in the life span of both sexes of *M. d. nebulo* when treated with apholate either in the larval stage or as adults.[8]

During the present studies the effects of a non alkylating agent, hempa on the sterility and longevity of different strains of *Musca domestica nebulo* have been determined.

Materials and Methods

The flies were obtained from a normal and DDT resistant strains of *M. d. nebulo*, maintained in the laboratory since 1961. They were reared at a temperature of 28±1°C on cotton pads soaked in diluted milk. Small petri dishes containing food were placed in each cage. The flies readilly oviposited on such pads and observations were taken at interval of 24 hours.

The sample of hempa was obtained through the courtesy of Dr. A. B. Borkovec In Charge, Pesticide Chemicals Research Branch, USDA, Beltsville, Maryland.

The flies were sexed on emergence and those belonging to the same sex were kept in a cage 3″×3″ constructed of wire frame and covered over by a mosquito netting. Acetone solutions of hempa were prepared and the desired concentra tions applied topically to the dorsum of each fly in the manner described by Abedi.[9] The size of drop applied was 0.0018cc throughout the experiments. Single pair reciprocal crosses were established between treated and normal males and females and also between treated males and females by placing the adults in small cloth cages. Fifteen pairs of each type were observed for fecundity and fertility. The observations were carried until the adults died. Eggs obtained from each female were counted under black background of moist black cloth piece and percentage hatch of the eggs determined after twenty four hours. Percent sterility and percent net sterility was calculated by the following formulae[10].

$$\frac{\text{Total number of unhatched eggs}}{\text{Total number of eggs laid}} \times 100 = \% \text{ Sterility}$$

$$\frac{\%\text{ Sterility in test} - \%\text{Sterility in normal}}{100 - \%\text{ Sterility in normal}} \times 100 = \%\text{Net Sterility}$$

Results

The results obtained (Tables 1-3) clearly indicate that hempa has a marked effect on the fecundity and fertility of normal and resistant strains of *M. d. nebulo*. The effect on the two sexes was more or less the same but it was more effective in males in comparison to females as far as the hatchability of eggs was concerned. The normal males when treated with 0.5, 1.0, 2.0 and 4.0% hempa and mated with virgin females induced 54.2, 86.09 and 94.09% net sterility respectively as against 39.6, 80.4 and 82.6% net sterility obtained in the case of treated females. When resistant males were treated with hempa and crossed with virgin females similarly 56.5, 76.02 and 89.9% net sterility was obtained as against 44.4, 70.9 and 69.07% net sterility in case where only females were treated. However when females were treated with 4.0% hempa a complete inhibition of oviposition was observed in normal as well as DDT resistant flies. This is in partial agreement with the earlier findings of Labrecque *et al*[5] who observed that hempa was less effective against females than the males. When only females were treated the hatch-rate was sufficiently higher but the average number of eggs laid by females was severly reduced. This supports the findings of Raghuwanshi[10] who also observed a marked reduction in the number of eggs per raft when females of *Culex fatigans* were treated with apholate, tepa and metepa. The degree of sterility increased when both sexes were treated. Normal females treated with 0.5, 1.0 and 2.0% hempa and mated with normal males produced 39.6, 80.4 and 82.6% net sterility respectively. When both sexes were treated the % net sterility produced was 71.02, 91.5 and 97.3 %. Similarly in the case of DDT resistant strain, treatment of both sexes enhanced the sterility effect. Taking net sterility as the criterion normal strain was found to be more susceptible to hempa than the DDT resistant strain.

Table 1. Effect of hempa on the fecundity and fertility of DDT resistant and normal strains of *M. d. nebulo*.

Strain	Conc.**	Sex treated											
		Male				Female				Male & Female			
Stage		Ovi-posited	Hatched	Hatch%	(%) Net sterility	Ovi-posited	Hatched	Hatch%	Net sterility	Ovi-posited	Hatched	Hatch%	Net sterility
Normal Adult	0.5	561.7	203.0	36.1	54.2	366.8	174.07	47.4	39.6	442.0	101.2	23.07	71.02
	1.0	487.4	48.5	9.9	86.09	257.07	39.7	15.4	80.4	297.1	19.6	6.3	91.5
	2.0	467.1	22.3	4.7	94.05	161.7	22.2	13.7	82.6	195.6	4.0	2.04	97.3
	4.0	488.4	0.0	0.0	100.0	—	—	—	—	—	—	—	—
Control	—	558.0	441.2	79.08	—	—	—	—	—	—	—	—	—
DDT resistant	0.5	401.5	128.5	31.9	56.5	390.7	159.5	40.8	44.4	308.2	67.4	21.8	70.5
	1.0	308.2	53.8	18.7	76.02	311.2	66.4	21.5	70.9	325.8	44.4	13.6	81.4
	2.0	447.9	33.7	7.5	89.9	214.1	47.6	22.2	69.07	252.8	11.2	4.4	94.05
	4.0	395.3	0.0	0.0	100.0	—	—	—	—	—	—	—	—
Control	—	496.3	364.8	73.4	—	—	—	—	—	—	—	—	—

* Net sterility calculated from formula suggested by Hair & Adkins (1964)
** A drop of 0.0018 cc. applied to each fly.

Hempa not only produced sterility but also affected the oviposition and longevity of flies. The pre-oviposition, oviposition and post-oviposition periods were considerably affected when adults were treated with this chemical (Tables 2-3). The pre-oviposition period was very much

Table 2. Effect of hempa on the oviposition and longevity of normal strains of *M. d. nebulo.*

Sex Treated	Stage Treated	concent-ration	Individual pairs		Duration in days			Longevity in days		
			Observed	Oviposited	Preoviposition period	Oviposition period	Postoviposition period	Female oviposited	Not oviposited	Males
Male	Adult	0.5	15	14	4.07	14.07	2.8	21.0	8.0	14.0
		1.0	15	14	4.3	13.3	3.2	22.5	6.0	13.7
		2.0	15	13	4.3	14.3	2.3	21.1	7.0	16.2
		4.0	15	15	5.4	15.4	3.6	24.0	—	15.0
Female	Adult	0.5	15	13	5.3	8.09	3.0	17.3	11.0	21.8
		1.0	15	13	4.2	14.1	2.6	20.9	7.0	21.8
		2.0	15	8	5.8	6.1	3.0	14.9	11.5	20.6
		4.0	15	—	—	—	—	—	12.9	16.6
Male & Female	Adult	0.5	15	14	4.6	15.5	2.9	23.1	6.0	18.0
		1.0	15	13	3.6	10.8	3.9	18.4	11.5	19.3
		2.0	15	10	5.8	6.1	6.0	17.6	16.8	20.8
		4.0	15	—	—	—	—	—	12.9	16.6
Control	Adult	—	15	15	3.3	23.6	2.8	29.3	—	25.3

Table 3. Effect of hempa on the oviposition and longevity of DDT resistant strain of *M. d. nebulo.*

Sex treated	Stage treated	concent-ration	Individual pairs		Duration in days			Longevity in days		
			Observed	Oviposited	Pre-oviposition period	Oviposition period	Post-oviposition period	Female oviposited	Not oviposited	Males
Male	Adullt	0.5	15	14	5.0	12.5	3.2	21.7	10.2	16.1
		1.0	15	15	3.4	9.4	3.8	16.7	—	15.6
		2.0	15	15	5.2	14.3	3.4	22.0	—	15.3
		4.0	15	15	6.0	11.7	2.9	20.6	—	10.6
Female	Adult	0.5	15	14	5.5	10.6	2.7	18.1	10.0	21.7
		1.0	15	14	4.8	9.6	4.2	17.4	6.0	19.06
		2.0	15	11	7.3	7.0	4.4	18.7	7.2	21.4
		4.0	15	—	—	—	—	—	16.4	24.0
Male & Female	Adult	0.5	15	14	4.9	11.06	2.5	19.5	11.0	16.1
		1.0	15	15	4.2	11.2	4.0	19.9	—	15.0
		2.0	15	13	6.4	8.0	4.7	19.1	10.0	16.4
		4.0	15	—	—	—	—	—	11.9	13.4
Control	Adult	—	15	15	4.9	12.9	3.2	21.1	—	20.06

enhanced when higher concenterations were applied to the adults but oviposition was inhibited so much so that no eggs could be obtained in cases where the flies were treated with 4.0% hempa.

The longevity of male and female flies belonging to both the normal and resistant strains was shortened and was inversely proportional to the concenteration tested (Tables 2-3). However the longevity of DDT resistant flies was not so much affected as that of the normal flies. There was a marked reduction in the life span of both sexes of flies belonging to the normal strain when reciprocal crosses were made. The longevity of control male was 25.3 days but when it was crossed with females that had been earlier treated

with 0.5, 1.0, 2.0 and 4.0% hempa, its longevity was reduced to 21.8, 21. 8, 20.6 and 16.6 days. Similarly the longevity of females which was 29.3 days, reduced to 20.0, 19.3, 18.6 and 24.6 days respectively when the flies were treated with the above concentrations. This difference was insignificant in the case of resistant males and females. Females which oviposited lived longer than those which did not lay eggs. This is in conformity with Raghuwanshi *et al.*[8] who also observed a longer life span in females of *M. d. nebulo* in all cases where the females had oviposited.

It is possible that the longevity affected by hempa may prove to be disadvantageous for sterile male release technique in controlling insect pests. In fact any chemosterilant which produce sterility and causes deleterious side effects may prove to be useless in the field. Hence a thorough knowledge of the biology of the insect to be treated and the concentrations of the chemical needed to sterilize should be clearly known. In the light of previous findings that chemosterilized males are as competitive as the normal males it seems reasonable to believe that sterile males would have an opportunity to mate with most of the females that emerged within the same week, before the chemical exerts any toxic effects on them.

Summary

The effect of non alkylating agent, hempa on the sterility and longevity of normal and DDT resistant strains of *M. d. nebulo* has been studied by applying the chemical topically on the dorsum of each fly. It was found that hempa hold promise as a chemosterilant and has marked effect on the oviposition and the viabiliy of the eggs. Both sexes were sterilized but it was more effective on males in comparison to females as far as the hatchability of eggs was concerned. However when 4.0% hempa was applied to the females a complete inhibition of oviposition was observed in normal and DDT resistant flies. Higher concenterations had pronounced effect on the pre-oviposition, oviposition and post-oviposition periods. The life span of both sexes was reduced when treated with hempa and was inversely proportional to the concentration tested. The longevity of females which oviposited was longer than those which did not oviposit.

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References

1) Labrecque, G. C. *et al* : *J Econ. Ent.* 53 (5), 802 (1960)
2) Labrecque, G. C. : *J. Econ. Ent.* 54 (4), 1684 (1961)
3) Chang, S. C. *et al* : *Science* 144, 57 (1964)
4) Fye, R. L. *et al* : *J. Econ. Ent.* 59 (2), 485 (1966)
5) Labrecque, G. C. *et al* ; *J. Med. Ent.* 3 (1), 40 (1966)
6) Murvosh. C. M. *et al* : *J. Econ. Ent.* 57 (1). 89 (1964)
7) Ladd, T. L ; *J. Econ. Ent.* 59 (2), 422 (1966)
8) Raghuwanshi, O. P. *et al* : *Botyu-Kagaku*, 33 (4), 119 (1968)
9) Abedi, Z. H. : C. R. 3e Congres de La P. I. O. S. A., Tananarive, Section B, 85 (1957)
10) Hair, J. A. and T. R. Adkins : *J. Econ. Ent.* 54 (4), 586 (1964)
11) Raghuwanshi, O. P. : Ph. D. thesis Muslim University, Aligarh 89 (1968)