Mitt. Zool. Mus. Berl. **66** (1990) 1, 59–64 20. 3. 1990

Effect of Different Concentrations of Thiourea on the Longevity, Fecundity, and Egg Hatchability of the Beetle, *Epilachna dodecastigma* (Muls.)

SHIV SHANKER, A. KUMAR, K. P. PANDEY and C. P. M. TRIPATHI

With 2 figures in the text

Abstract. The present paper elucidates that 0.005 to 0.05 per cent of thiourea has no significant effect on the longevity of *Epilachna dodecastigma*. However, when the concentration was raised from 0.05 to 0.10 per cent ($t = 7.72$, $P < 0.001$) and from 0.10 to 0.20 per cent ($t = 1.90$, $P < 0.20$), the longevity of the beetles was significantly reduced. Further, it has also been observed that as the concentration of thiourea increases, the number of eggs laid by the beetle decreases and complete sterility was achieved when 0.05 per cent of thiourea was applied. Therefore, 0.05 per cent of thiourea concentration is the most suitable dose for the sterilization of *E. dodecastigma*.

Key words: Insecta, Coleoptera, Coccinellidae, *Epilachna dodecastigma*; chemosterilization; thiourea.

Introduction

The concept of decreasing populations of rapidly reproducing organisms by reducing their birth rates rather than by increasing their death rates found its more striking application in the field of insect pests (KNIPLING 1960). Sterility in insects has been found to be introduced either by their exposure against radiation (WEIDHAAS 1973; MILLER & WEIDHAAS 1974; BUSHLAND 1975) or by chemosterilants (CRYSTAL 1972; CHAUDHRY & TRIPATHI 1976, 1977; TRIPATHI 1981). Chemosterilants score and edge over radiation because they are relatively cheap and are easy to use when compared to the expensive equipment needed for irradiation (JAMES 1972). Besides, they have been reported to have less adverse effect on the longevity and mating competitiveness. Several workers have observed that the treated insects have reduced fecundity (CRYSTAL & LACHANCE 1963; LACHANCE & LEVERICH 1968; BEATTIE 1979) and egg hatchability (MATOLIN & SKUHRAVY 1976; CRYSTAL 1978). The potentialities of chemosterilization for the control of insect pests have been elaborated by KNIPLING (1962, 1963), BORKOVEC (1971, 1979), CRYSTAL (1972, 1975), CHAUDHRY & TRIPATHI (1976, 1977), TRIPATHI (1981), CRYSTAL & HAUGHT (1982), and SATYANARAYANA & SUKUMAR (1985). The chemosterilant thiourea has been found to induce sterility in many insects, viz., *Cochliomyia hominivorax* (GOUCK et al. 1963), *Sarcophaga ruficornis* (CHAUDHRY & TRIPATHI 1976; TRIPATHI 1981), and *Musca domestica* (HALL et al. 1979). *Epilachna dodecastigma* is a serious pest of most of the cucurbitaceous plants of this region. In the present work an attempt has been made to observe the effect of thiourea on the longevity, fecundity, and egg hatchability of the beetle, *E. dodecastigma*.

Materials and Methods

Newly emerged female beetles, *E. dodecastigma* were obtained from the culture maintained in the laboratory at 27 ± 4 °C and 95 ± 3% RH and were divided into seven groups. The beetles of the 1st, 2nd, 3rd, 4th, 5th, and 6th group were fed on leaves of *Luffa cylindrica* soaked for 15 minutes in distilled water containing different concentrations (0.005, 0.010, 0.025, 0.05, 0.10 and 0.20 per cent) of thiourea, respectively, whereas the beetles of the 7th group (used as control) were fed with leaves of *L. cylindrica* soaked in distilled water for 15 min. The beetles of all the seven groups were allowed to mate with unmated fresh males of the same age. The number of eggs laid by both the treated and control beetles were collected daily and counted in order to calculate the realised fecundity. The eggs hatched from the treated and control groups were counted and the observed sterility was calculated by applying Chamberlain's formula (1962).

Results and Discussion

It was observed that the normal life span of adult *E. dodecastigma* is about 37 days and that it becomes sexually mature on the 4th day after emergence. The first batch of eggs was laid by the beetles on 7th day of their emergence. The female laid about 386 eggs in her lifetime.

When the adult *Epilachna* were fed on the leaves containing 0.005 per cent thiourea, the beetles were alive for 35 days. Mating took place like with normal individuals and the first batch of eggs was laid on the 7th day of emergence. Altogether 337 eggs were laid by the beetles, out of which 271 eggs hatched, i.e., 80 per cent hatching was recorded (Table 1).

When the concentration of thiourea was increased to 0.01 per cent, the beetles survived 34 days. Mating was normal and it took place on the 4th day after emergence. After mating the first batch of eggs was laid on the 7th day. Altogether 234 eggs were laid throughout the life span, out of which only 72 eggs hatched, i. e., about 37 per cent hatching took place (Table 1).

Beetles fed with 0.025 per cent thiourea were found to be alive for 33 days. Normal mating was recorded and it took place on the 4th day after emergence. The first batch of eggs was laid on the leaves of *Luffa* on 7th day of emergence. 102 eggs were laid throughout the life span, out of which only 23 eggs hatched, i.e., 22.54 per cent hatching was recorded (Table 1).

When *E. dodecastigma* were administered with 0.05 per cent thiourea (in the soaked leaves), it was found that the beetles survived up to 31 days. Normal mating was observed on the 4th day after emergence. However, in this case no eggs were obtained throughout the observation period and complete sterility was achieved (Table 1).

When beetles got food (leaves) containing 0.10 per cent thiourea, they remained alive up to 12 days. In this case, though the mating occurred and that also on the 4th day after emergence, the mating period was quite short. No egg laying was recorded throughout the survival period (Table 1).

Epilachna fed on the leaves containing 0.20 per cent thiourea survived only up to 5 days. No mating was observed in these beetles (Table 1).

Table 1 shows that concentrations from 0.005 to 0.05 per cent thiourea have no significant effect on the longevity of *E. dodecastigma*. However, when the concentration of thiourea was raised from 0.05 to 0.10 per cent ($t = 7.72$, $P < 0.001$) and from 0.10

Table 1
Effect of thiourea on the longevity, fecundity and sterility of *E. dodecastigma*.

Dose (in conc.) %	Longevity in days (mean ± SD)	No. of eggs laid/♀ (mean ± SD)	No. of eggs hatched (mean ± SD)	Observed sterility %	Corrected** sterility %
0.005	35.3 ± 6.11 t = 0.08*	337 ± 22.04 t = 7.64[a]	271 ± 15.36 t = 22.61[a]	19.58	13.78
0.01	34.2 ± 5.94 t = 0.21*	234 ± 20.51 t = 11.18[a]	72 ± 12.30 t = 7.07[a]	69.23	60.58
0.025	33.4 ± 5.92 t = 0.57*	102 ± 16.62	23 ± 9.41	77.45	75.83
0.05	31.6 ± 5.11 t = 7.72[a]	—	—	100.00	100.00
0.10	12.1 ± 7.65 t = 1.90[c]	—	—	—	—
0.20	5.2 ± 2.69	—	—	—	—
Control	36.8 ± 6.21	386 ± 28.41	360 ± 16.34	6.73	—
Between 0.20 and 0.005	t = 10.08[a]	—	—	—	—
Between 0.005 and control	t = 0.38*	t = 3.05[b]	t = 9.77[a]	—	—

Significant at the level of [a]0.001, [b]0.05, [c]0.20 and * not significant.

**Calculated by Chamberlain's formula (1962) = $\frac{\%\text{ hatch in control} - \%\text{ hatch in treated}}{\%\text{ hatch in control}} \times 100$.

to 0.20 per cent ($t = 1.90$, $P < 0.20$), the longevity of the beetles was significantly reduced (Table 1, Fig. 1). This shows that 0.10 and 0.20 per cent of thiourea has lethal effect. A decrease in the number of eggs laid by the beetles with the increase of thiourea concentration clearly indicate that thiourea prevents the embryonic development of ovary (Table 1, Fig. 2). Similar observations have been made by MATHEW & RAI (1975), GELBIC & SOCHA (1976), HANIOTAKIS & CATSOULACOS (1977), BEATTIE (1979), HALL et al. (1979), SARASUA et al. (1983) and SUCHARIT et al. (1984) in many other insects by applying various chemosterilants. SAXENA & MATHUR (1981) while working on the eggs of *Tribolium castaneum* with benzoylphenyl urea compound further reported that the egg shells split, but the larvae fail to emerge from the eggs. The death of offspring may be due to the longer degree of rigidity in cuticle which fails to resist the muscular traction during hatching, thereby, resulting in the death of larvae within the eggs (SATYANARAYANA et al. 1985). Interestingly, when the thiourea concentration was raised from 0.025 to 0.05 per cent, complete sterility was achieved as no egg laying occurs throughout the beetles' life-span without much adverse effect on the longevity. Histopathological studies of the ovary of *Epilachna* at this concentration show that the transport of vitellogenin — the major source of yolk protein — from the haemolymph to the developing oocyte is completely stopped with the result that the oocyte remains

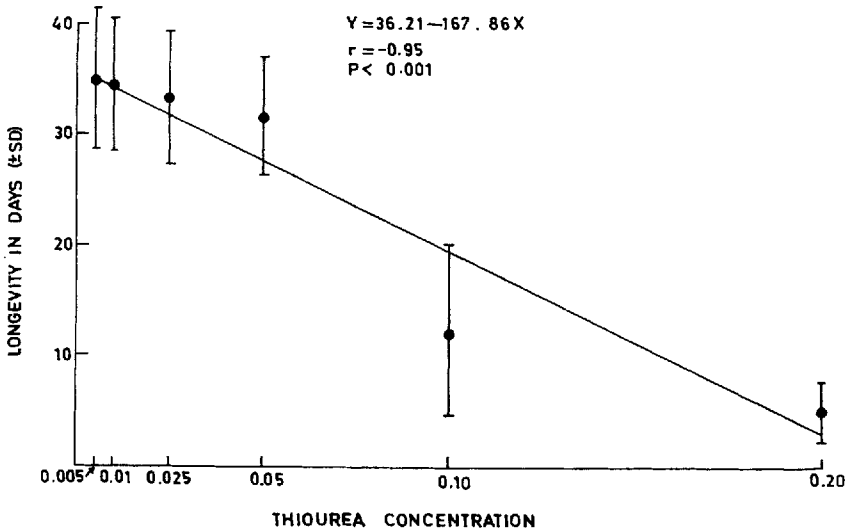

Fig. 1. Graphic representation of effect of thiourea on the longevity of *E. dodecastigma*

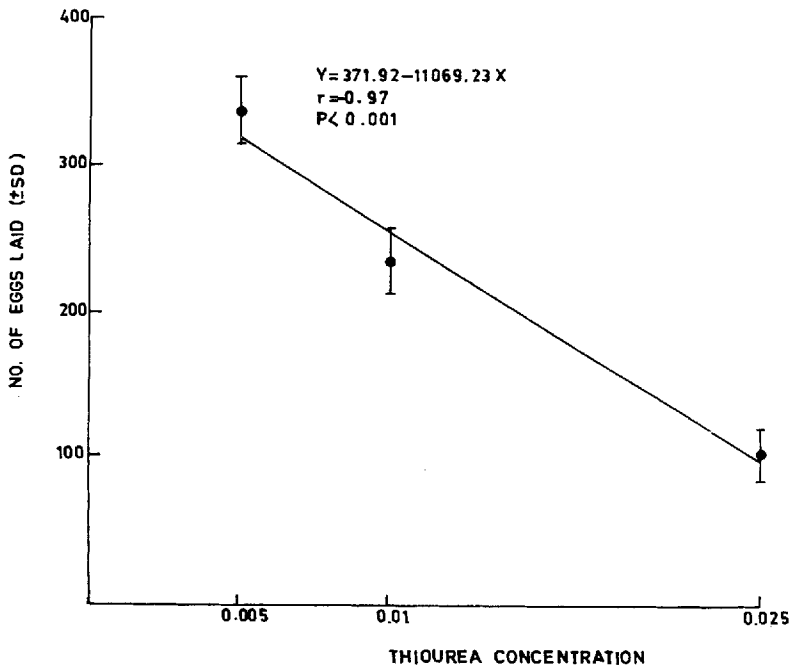

Fig. 2. Graphic representation of effect of thiourea on the fecundity of *E. dodecastigma*

underdeveloped (SHANKER & TRIPATHI, 1986). SATYANARAYANA & SUKUMAR (1985) have made identical observations in soap nut bugs *Leptocorisa coimbatorensis* by treating them with penfluron. They found that at 3 per cent concentration remarkable retardation of reproductive system occurs and fecundity became nil.

The results dicussed so far reveal that of all the concentrations applied, 0.05 per cent thiourea was found to be most suitable as at this concentration 100 per cent sterility was induced in the adult *E. dodecastigma* without much affecting its normal life span and mating vigour. Therefore, 0.05 per cent thiourea concentration is the most suitable dosage for sterilization of *Epilachna*.

Acknowledgement

CSIR New Delhi, is acknowledged for financial assistance.

References

BEATTIE, G. A. C. (1979): Oogenesis in *Lucilia cuprina* (Wied.) (Diptera: Calliphoridae). II. The effect of aziridinyl chemosterilants on oogenesis. — Aust. J. Zool. **27**, 349—362.

BORKOVEC, A. B. (1971): The role of the sterility technique in pest control. — Israel J. Entomol. **6**, 183—189.

— (1979): Insect reproduction suppression by inhibitors of chitin-synthesis. — II. Int. Symp. Invertebr. Reprod., Davis. C. A.

BUSHLAND, R. C. (1975): Screw worm research and eradication. — Bull. Entomol. Soc. Am. **21**, 23—26.

CHAMBERLAIN, W. F. (1962): Chemical sterilization of the screw-worm. — J. Econ. Entomol. **55**, 240—248.

CHAUDHRY, H. S. & TRIPATHI, C. P. M. (1976): Histopathological effect of thiourea on ovarian tissues of *Sarcophaga ruficornis* (Fabr.). — Experientia **32**, 103—104.

— & — (1977): Susceptibility of female gonads of *Sarcophaga ruficornis* (Fabr.) (Diptera: Sarcophagidae) to thiourea in relation to their age. — J. med. Ent. **13**, 571—573.

CRYSTAL, M. M. (1972): Chemosterilization of male screw-worm flies by immersion: Changes in susceptibility with time of treatments, permanence of sterility, and effect of treatment on survival. — J. med. Ent. **9**, 509—510.

— (1975): Chemosterilization of screw-worms (Diptera: Calliphoridae): Influence of age at time of treatment on sterility and longevity. — J. med. Ent. **12**, 423—425.

— (1978): Diflubenzuron-induced decrease of egg hatch of screw-worms (Diptera: Calliphoridae). — J. med. Ent. **15**, 52—56.

— & LACHANCE, L. E. (1963): The modification of reproduction in insects treated with alkylating agents. I. Inhibition of ovarian growth and egg production and hatchability. — Biol. Bull. **125**, 270—277.

— & HAUGHT, S. B. (1982): Chemosterilization of male tobacco budworm moths (Lepidoptera: Noctuidae): Some effects on reproductive physiology. — Ann. Ent. Soc. Am. **75**, 684—689.

GELBIC, I. & SOCHA, R. (1976): The effects of the chemosterilant metepa on the development of ovaries of *Dixippus morosus*. — Acta ent. bohemoslov. **73**, 224—233.

GOUCK, H. K., CRYSTAL, M. M., BORKOVEC, A. B. & MEIFERT, D. W. (1963): A comparison of techniques for screening chemosterilants of house flies and screw-worm flies. — J. econ. Entomol. **56**, 506—509.

HALL, R. D., VANDEPOPULIERE, J. M. & LYONS, J. J. (1979): Laboratory response of susceptible house flies to thiourea as a larvicide and chemosterilant. — J. econ. Entomol. **72**, 204—207.

HANIOTAKIS, G. E. & CATSOULACOS, P. (1977): A new chemosterilant for *Dacus oleae* (Gmelin). — Ann. Zool. Écol. Anim. **9**, 149—153.

JAMES, P. E. (1972): Methods and equipment for irradiating insects. — Trans. Am. Soc. Agric. Eng. **115**, 160—162.

KNIPLING, E. F. (1960): The eradication of screw worm. — Sci. Am. **203**, 54—61.

— (1962): Potentialities and progress in the development of chemosterilants for insect control. — J. econ. Entomol. **55**, 782—786.

— (1963): Alternate methods in pest control publications. 1082, pp. 23—27.

LACHANCE, L. E. & LEVERICH, A. P. (1968): Cytology of oogenesis in chemosterilized screw worm flies, *Cochliomyia hominivorax*. — Ann. Ent. Soc. Am. **61**, 1188—1197.

MATHEW, G. & RAI, K. S. (1975): Chemosterilant (apholate) induced ultrastructural changes during oogenesis in *Aedes aegypti*. — Cytobios. **12**, 45—46.

MATOLIN, S. & SKUHRAVY, V. (1976): The effect of metepa on the embryonic development of the colorado beetle, *Leptinotarsa decemlineata*. — Acta ent. bohemoslov. **73**, 302—304.

MILLER, D. R. & WEIDHAAS, D. E. (1974): Equilibrium populations during a sterile-male release program. — Environ. Entomol. **3**, 211—216.

SARASUA, M. J., AWAREZ, C. & SANTIGO (1983): Effect of diflubenzuron on the fecundity of *Ceratitis capitata*. — Ent. exp. & appl. **32**, 223—225.

SATYANARAYANA, K. & SUKUMAR, K. (1985): Sterility and retardation of oocyte growth by penfluron on soapnut bug *Leptocoris coimbatorensis* (Gross) (Hemiptera: Coreidae). — Z. ang. Ent. **100**, 367—372.

—, REENA, C. & SUKUMAR, K. (1985): Penfluron induced sterility and ovarian inhibition in *Dysdercus cingulatus* F. — Internat. Pest Control **27**, 47—48.

SAXENA, S. C. & MATHUR, G. (1981): Suppression of adult emergence on treating eggs of *Tribolium castaneum* (Herbst) by new synthesized di-substituted benzoyl phenyl urea compounds. — Curr. Sci. **50**, 336.

SHANKER, S. & TRIPATHI, C. P. M. (1986): Histopathological effect of thiourea on the ovarian tissues of beetle, *Epilachna dodecastigma* (Muls.) (Coleoptera: Coccinellidae). — J. Adv. Zool. **7**, 100—104.

SUCHARIT, S., KERDPIBULE, V., CHOMCHARAN, Y. & LIMSUWAN, S. (1984): *Plasmodium falciparum* infection in bisazir chemosterilized *Anopheles dirus* in laboratory studies. — Southeast Asian J. Med. Pub. Hlth. **15**, 228—233.

TRIPATHI, C. P. M. (1981): Induction of sexual sterility in the flesh-fly *Sarcophaga ruficornis* (Fabr.) (Diptera: Cyclorrhapha) by treating its larval stages with thiourea. — J. Adv. Zool. **2**, 16—24.

WEIDHAAS, D. E. (1973): Principles of the sterile male technique with emphasis on ecology. — In: Computer Models and Application of the Sterile-male Technique. Vienna: Internat. Atomic Energy Agency, pp. 17—22.

Address of the authors: Dr. SHIV SHANKER, Dr. A. KUMAR, Dr. K. P. PANDEY, and Dr. C. P. M. TRIPATHI, Laboratory of Entomology, Department of Zoology, University of Gorakhpur, Gorakhpur-273009, India