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Toxicity and the effect of Zineb on the rate of development of *Drosophila melanogaster*

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Abstract. Zineb [Zinc ethylene bis (dithiocarbamate)], a carbamate fungicide was analysed for its toxicity on *Drosophila melanogaster*. Different concentrations of the chemical were added to the food medium and fed to the larvae. Based on this the LC_{50} was calculated to be 58·26 mg/100 ml food medium. The toxic efficacy, of Zineb on the rate of development and viability of *D. melanogaster* compared to Dithane M–45, a related carbamate, are discussed.

Keywords. Zineb ; rate of development ; viability ; *Drosophila melanogaster*.

1. Introduction

Carbamate compounds are increasingly being used in agriculture and a majority of them are found to pollute the environment. Hence these compounds need to be evaluated for their toxicity and mutagenecity, if any, in the appropriate test systems in order to understand their somatic and genetic effects. Zineb [Zinc ethylene bis (dithiocarbamate)] is one such carbamate pesticide extensively used in agriculture. Cytogenetic effects of Zineb on different test systems such as *Allium cepa* (Sathaiah and Venkat Reddy 1973), mice (Seiler 1977) and lymphocyte cultures of occupationally exposed workers (Pilinskaya 1977) have been analysed. Studies on the mutagenecity of Zineb on *Drosophila melanogaster* have been made by injecting the chemical into their abdomen (Benes and Sram 1969). Balasubramanian and Rangaswami (1974) and Hodgson and Lee (1977) have demonstrated the toxic effects of Zineb on *Pseudomonas solanacearum* and Chinese hamster ovary cells in culture respectively.

The present investigation is to evaluate the toxicity of Zineb and its effect on the rate of development using *D. melanogaster* as a test system.

2. Materials and methods

Isofemale line of *D. melanogaster* (Oregon-K strain) served as the test material for the present experiments. The procedure of Delcour (1969) was followed to obtain

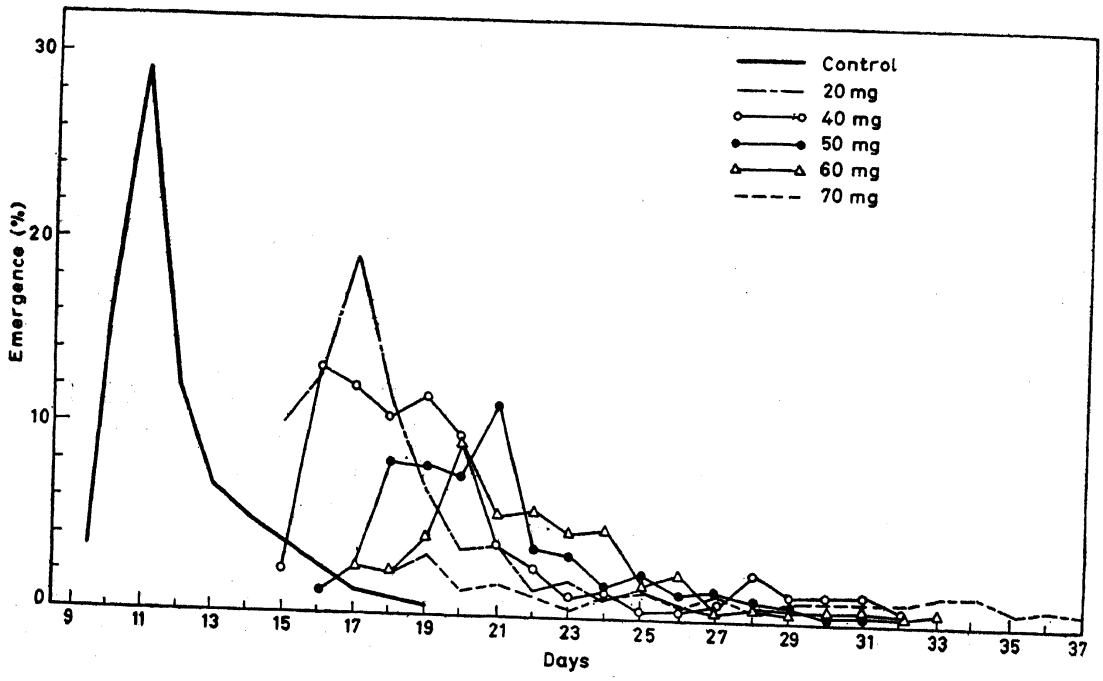

Figure 1. Pattern of emergence of *D. melanogaster* in control and in different concentrations of Zineb.

eggs of the same age. In order to feed the chemical to the larvae, equal number of eggs (30 eggs/vial) were placed in 3″ × 1″ vials containing chemical supplemented wheat cream agar medium. Different concentrations of 20, 40, 50, 60 and 70 mg of Zineb (Trade name: Dithane Z–78 of Indofil Chemicals, Bombay) were thoroughly mixed in 100 ml of wheat cream agar medium. Eggs placed in normal food medium served as control. The experiments were carried out at constant temperature of 23 ± 1° C. The flies were counted and sex was noted every day after emergence. The LC_{50} was determined by probit analysis (Busvine 1971).

3. Results and discussion

The pattern of emergence of *D. melanogaster* in control and in different concentrations of chemical is showed in figure 1. The adult emergence in control started on the 9th day and reached the peak on the 11th day followed by sudden decline in emergence which terminated on the 19th day. The pattern of emergence obtained for the lowest concentration of 20 mg showed that the emergence started on the 15th day and ended on the 29th day whereas in highest concentration of 70 mg the emergence was recorded on the 18th day and terminated on the 37th day.

Change in the rate of development is the manifestation of interaction between the genotype and environment (Bonnier 1960). The latter includes crowding, temperature, space, etc. In the present experiments, environmental factors being constant, the difference in the rate of development and viability is ascribed to the different concentrations of the chemical in the food medium (table 1). Retardation of development is a good indication of somatic effects caused by the chemical

Table 1. Mean developmental period[+] and viability[++] of *Drosophila melanogaster* in control and in different concentrations of Zineb.

Treatment	Mean developmental period (in days)			Viability	
	For group	For males	For females	No. of flies emerged out of 900 eggs	% Viability
Control	11·51 ± 0·07	11·54 ± 0·11	11·34 ± 0·21	847	94·11
20 mg	17·97 ± 0·10*	17·84 ± 0·15	18·08 ± 0·15	679	75·44
40 mg	19·44 ± 0·14*	19·38 ± 0·21	19·50 ± 0·20	570	70·37*
50 mg	20·97 ± 0·13*	21·01 ± 0·19	20·86 ± 0·19	490	54·44*
60 mg	21·97 ± 0·17*	21·92 ± 0·21	22·03 ± 0·28	389	44·33*
70 mg	25·88 ± 0·40*	24·73 ± 0·59	26·87 ± 0·54	211	23·44*

[+]C.D. value = 0·25; [++]C.D. value = 4·38; * Significant at 5% level.

in test substrate (Luning 1966). In the present investigations, there is the prolongation of rate of development in all batches of chemical food medium and the delay in the rate of development is directly proportional to the concentration of the chemical in the food medium.

The mean developmental time has been calculated for the groups as well as for sexes (table 1). Significant retardation of development was observed even in the lowest concentration tested. However, none of the concentrations has significant impact on the mean developmental period on either of the sexes. Studies by Balasubramanian and Rangaswami (1974) have revealed that Zineb could cause retarded development in *Pseudomonas solanacearum*. Similar findings on the effect of other chemicals on the rate of development in *Drosophila* have been well documented (Forman and Majumdar 1971; Laamanen *et al* 1976; Rajasekarasetty *et al* 1979; Vasudev and Krishnamurthy 1979; Krishnamurthy and Vijayan 1979). The present findings of the authors support the results of the earlier workers.

Lethality is another parameter by which the toxicity of a particular substance could be assessed. The percentage lethality in various concentrations between control and the treated series clearly shows significant reduction in viability in concentrations of 40, 50, 60 and 70 mg of Zineb. Further, the extent of lethality is directly proportional to the concentration of the chemical used. Similar results on the dose response relationship of concentration of chemical and lethality have been demonstrated (Sorsa and Pfeifer 1973; Laamanen *et al* 1976; Rajasekarasetty *et al* 1978; Vasudev and Krishnamurthy 1979; Krishnamurthy and Vijayan 1979). X^2 homogeneity test has been employed to analyse the differential sensitivity of male and female larvae in the same concentration of chemical (table 2). It is evident that male and female larvae have the same sensitivity in each of the concentrations used except in 60 mg, where the female larvae were more sensitive than the male ones ($X^2 = 3·82$, $p = 0·05$–$0·1$). Similarly, studies

Table 2. X^2 homogeneity test for the viability of males and females in each group.

Concentration	No. of eggs laid	No. of flies emerged		X^2	p value
		Males	Females		
Control	900	428	419	0·09	0·9 –0·7
20 mg	900	321	358	0·02	0·2 –0·1
40 mg	900	287	283	0·03	0·9 –0·7
50 mg	900	249	241	0·13	0·9 –0·7
60 mg	900	219	180	3·82	0·05–0·1
70 mg	900	98	113	1·06	0·5 –0·2

by Vasudev and Krishnamurthy (1979) on the toxicity of Dithane M-45 on *D. melanogaster* has revealed that female larvae are more sensitive than male larvae, exclusively in cultures with 20 mg concentration of Dithane M-45/100 ml food medium. Present finding of the authors have revealed that the LC_{50} for Zineb on *D. melanogaster* is 58·26 mg/100 ml (calculated by probit analysis) compared to the findings of Vasudev and Krishnamurthy (1979) where LC_{50} of Dithane M-45 on *D. melanogaster* was shown to be 17·5 mg/100 ml.

Thus it can be inferred that Zineb is less toxic than Dithane M-45 in *D. melanogaster*.

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