

THE EFFECT OF TEMPERATURE AND HUMIDITY ON THE SUSCEPTIBILITY OF FLOUR BEETLES TO INSECTICIDES

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The susceptibility of the flour beetle, *Tribolium castaneum* Herbst. to DDT and dieldrin was investigated at different controlled conditions of temperature and humidity. It was found that the susceptibility was influenced significantly by temperature though not by humidity. DDT exhibited negative temperature coefficient whereas the temperature coefficient for dieldrin was positive. *T. castaneum* was found to be more susceptible to DDT at 20–25°C than at 30–35°C whereas the insect was more susceptible to dieldrin at 30–35°C than at 20–25°C.

There is increasing evidence in literature to show that susceptibility of insects to insecticides is influenced by environmental conditions. Studies on the effect of temperature and humidity on the action of insecticides on different species of insects have interested many workers (Potter and Gilham¹, Pradhan^{2,3}, Teotia and Dahm⁴, Mc Intosh⁵, Vinson and Kearns⁶, Collins and King⁷, Pradhan and Srivastava⁸, Burnett⁹, Pruthi¹⁰, Barlow and Hadaway¹¹, Pradhan and Rangarao¹², Pradhan and Mundkur¹³, Koshi and Ranganathan¹⁴). Such studies, particularly in India where the ambient conditions of temperature and humidity vary considerably from one area to another, will have great impact on the choice of insecticides for insect control. It appeared of interest, therefore, to study the effect of temperature and humidity on the susceptibility of some insects of economic importance to certain chlorinated hydrocarbon insecticides and organophosphorous compounds. This paper reports results on the susceptibility of the flour beetle, *Tribolium castaneum* Herbst. to DDT and dieldrin, under different conditions of temperature and humidity.

MATERIALS AND METHODS

Adult flour beetles, *T. castaneum*, 3 to 5 weeks old, drawn from laboratory cultures were used as test insects. The insects were reared in a room maintained at 27–29°C and 70–75 per cent RH, by the method described by Haq *et al.*¹⁵. The insecticides used were DDT (technical) and dieldrin obtained from the trade.

EXPERIMENTAL

The susceptibility of *T. castaneum* to DDT and dieldrin was investigated on oil residual films of the insecticides on filter papers. The insecticidal solution was obtained by dissolving requisite amount of the insecticide in liquid paraffin and subsequently diluting with petroleum ether (1 : 2). 'Whatman' filter papers (No. 1, 11 cm) were laid flat on pin points and one millilitre of the insecticidal solution was delivered on each filter paper with a hypodermic syringe. The filter papers were then allowed to dry for three hours in a room

TABLE—*contd.*

Insecticide	Temp. °C	RH%	Heterogeneity	Regression Equation	LC ₅₀ %	S.E. of LC ₅₀	Fiducial Limits of LC ₅₀
	20	30	$\chi^2_{(2)} = 0.2733$	$Y = 2.2005x + 7.3454$	0.0859	0.0553	0.0669 0.1103
		90	$\chi^2_{(2)} = 0.1502$	$Y = 4.4328x + 9.6965$	0.0872	0.1835	0.0381 0.1996
	25	30	$\chi^2_{(2)} = 0.0837$	$Y = 1.7062x + 7.1173$	0.0574	0.0836	0.0394 0.0837
		90	$\chi^2_{(2)} = 0.5308$	$Y = 2.2095x + 7.6475$	0.0634	0.0683	0.0466 0.0862
DIELDRIN	30	30	$\chi^2_{(2)} = 0.0662$	$Y = 2.7414x + 11.2190$	0.0054	0.0568	0.0042 0.0070
		90	$\chi^2_{(2)} = 0.0562$	$Y = 1.6653x + 8.9565$	0.0042	0.1116	0.0025 0.0070
	35	30	$\chi^2_{(2)} = 20.4440$	$Y = 4.8367x + 13.7263$	0.0157	0.0676	0.0096 0.0257
		90	$\chi^2_{(2)} = 7.8479$	$Y = 3.5730x + 11.5062$	0.0151	0.0265	0.0129 0.0190

X = Log concentration

Y = Probit kill

TABLE 2
ANALYSIS OF VARIANCE OF LC_{50}

Source of Variation	DDT				DIELDRIN				
	d.f.	S.S.	M.S.	F	d.f.	S.S.	M.S.	F	
Between temperature	3	0.0852	0.02840	86.06**	3	0.079461	0.026487	563**	
Between relative humidity	1	0.0009	0.00090	2.73	1	0.000033	0.000033	41	
Error	3	0.0010	0.00033		3	0.000141	0.000047	—	
Total	7	0.871	0.02963	88.79	7	0.079635	0.026567	604	
**Significant at 1% level.									
DDT									
Average LC_{50} (%)		Temperature °C		0.0430		0.0650		0.1723	
				25		20		30	
				35				35	
DIELDRIN									
Average LC_{50} (%)		Temperature °C		0.0144		0.0462		0.1812	
				30		35		25	
				30				20	

at 27—29°C and 70—75 per cent relative humidity, before exposure of the insects. The assessment was carried out by confining 25 insects for 48 hours within a clean glass ring (7.5 cm dia.) in a petri dish (11.0 cm dia.) lined with the treated filter papers. The glass rings were covered with wire mesh covers. After the exposure, the insects were transferred into a clean petri dish lined with untreated filter paper. Observations on the mortality were recorded 24 hours thereafter. There were two replicates in each assay. The investigations were conducted, at controlled conditions of temperature and humidity, in incubators at 20, 25, 30 and 35°C and at two different humidity levels, 30 and 90 per cent. The requisite humidities were maintained by the use of suitable concentrations of potassium hydroxide in water¹⁶. The solutions of potassium hydroxide were introduced in desiccators which were then placed in incubators.

RESULTS AND DISCUSSION

The results obtained in the various experiments were subjected to probit analysis¹⁷ and are summarized in Table 1. The analysis of variance of LC_{50} values is given in Table 2. It will be noted from these data that the susceptibility of *T. castaneum* to DDT and dieldrin is influenced significantly by temperature though not by humidity. Pradhan³, however, observed that high humidity during the continuous exposure period, increased the toxicity of DDT to *T. castaneum*; and higher humidity, after the exposure, increased the susceptibility of the insect to the insecticide. Collins and King⁷ on the other hand reported that the level of humidity after treatment had no effect on the susceptibility of *T. castaneum* to DDT applied on filter papers.

It will be observed from the LC_{50} values that DDT exhibits negative temperature coefficient. The LC_{50} values for the insecticide do not differ significantly at 20° and 25°C (Table 2) although the LC_{50} values are higher at 35°C than at 30°C. This would indicate that at higher temperatures (30°C and 35°C) the susceptibility of *T. castaneum* to DDT varies with temperature whereas at the lower temperatures (20° and 25°C) the susceptibility is nearly the same irrespective of the temperature. Pradhan³ reported that when the flour beetles are continuously exposed on DDT films at different temperatures viz., 56°—58°, 70°, 80° and 90°F there is a higher kill at the higher temperatures.

The LC_{50} values for dieldrin, in general, show a decrease with rise in temperature thereby exhibiting positive temperature coefficient of the insecticide. This would indicate that *T. castaneum* is more susceptible to dieldrin at the higher temperatures (30° and 35°C) than at the lower temperatures (20° and 25°C).

Pradhan and Bhatia¹⁸, Shi *et al*¹⁹ and Wal *et al*²⁰ have reported that *T. castaneum* is more susceptible to dieldrin than to DDT. The results (Table 1 and 2), however, have shown that the susceptibility is dependent on temperature, that is, only at the higher temperatures investigated (30° and 35°C) the insect is more susceptible to dieldrin than to DDT, whereas at the lower temperatures (20 and 25°C) the insect is more susceptible to DDT than to dieldrin.

ACKNOWLEDGEMENT

The authors desire to thank Dr. J. N. Nanda, Director, for encouragement and interest in the work. Thanks are also due to Shri R. K. Tripathi for assistance in statistical analysis.

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