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Effect of Sunlight on The Persistency and Residual Toxicity of Synthetic Pyrethroids

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ABSTRACT

The assessment of residual toxicity and persistence of synthetic pyrethroids,fenvalerate and cypermetrin films on glass petridishes exposed to sunlight and shade was conducted in the present study. An exposure of fenvalerate and cypermethrin deposits on glass surface to sunlight had reduced the effectiveness of insecticides, as was evident by high values of LC $_{50}$. Deterioration in the toxicity of these pyrethroids took place quicker where the treated petridishes were exposed under 8h sunlight and 16h shade conditions per day (excluding the days on which were released on the treated surface) than the continuous 24h shade conditions.

Key Words: Synthetic pyrethroids, fenvalerate, cypermethrin, sunlight, LC_{50}

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INTRODUCTION

The natural pyrethrin and synthetic pyrethroid insecticides have been considered as safest class of insecticides available [8]. Synthetic analogs or pyrethroids, evolved from natural compounds by successive isosteric modifications, are more potent, stable and are newest important class of crop protecting chemicals. Due to lack of effectiveness and sensitivity to sunlight [21], these synthetic pyrethroids were not much popularised for agriculture purpose except sanitary or household pests. Considering the importance of sunlight in affecting the efficacy of synthetic pyrethroids, the present studies were conducted to determine the effect of sunlight on the persistency of the toxicity and residual effects of fenvalerate and cypermethrin deposits on glass surface.

MATERIAL AND METHODS

The assessment of residual toxicity and persistence of fenvalerate (source: Searle India (Pvt.) Limited, Bombay, India) and cypermetrin(source: Hoechest India Limited, Hoechst Centre, Bombay, India) films on glass petridishes exposed to sunlight and shade was done. The films of three concentrations of 40, 80, 160 ppm and 4, 8, 16 ppm offenvalerate and cypermethrin, respectively, were prepared in the glass petridishes (10cm in diameter) using 1 ml of insecticidal solution delivered by a micropipette and surface was tilted carefully to allow uniformity in spread of insecticide solution. Petridishes treated with 1 ml of carbon tetrachloride only were served as control. Each treatment including control was replicated thrice.

The natural sunlight was utilised to observe the effect on residual toxicity and persistence of the insecticides deposited on glass surface. In order to deduce the effect of direct sunlight, some of the parallel samples were kept side by side in shade at the same condition of environment. the untreated petridishes were exposed for about 8 h daily (except the days on which insects were released on the treated surfaces) in the sunlight from 9 A. M. To 5 P. M. The treated petridishes were covered with the lids to avoid dust particles.

For each observation treated petridishes exposed to sunlight and shade were brought at definite time interval in the laboratory and kept in dark. The freshly emerged (0-3 days old) *Callosobruchuschinensis* adults of both sexes were released in batches of 20 insects in each treated petridish and covered with lid. Mortality counts were made 24h after release of insects and moribund insects were also counted as a dead. This was repeated till mortality was observed on insecticidal films of all three concentrations. The observation recorded were – number of insects died and period (in days) up to which mortality occurred. The percent mortality was calculated and corrected for control mortality by using Abbott's formula [1]. LC_{50} (median lethal concentration) were determined according to the ProbitAnalysis as suggested by Finney [6]. The corrected mortality and LC_{50} values were used as criteria for comparison of residual toxicity.

RESULTS AND DISCUSSION

The effect of sunlight on the persistency of the toxicity and residual effects of fenvalerate and cypermethrin deposits on glass surface recorded are presented in table 1. The toxicity persisted longer under shade condition than when exposed to sunlight which caused a greater reduction in the persistency of the toxicity. $LC_{50}$of fenvalerate increased to 281.84 ppm after a lapse of 29 days for deposit stored under shade condition while it was 278.61 ppm on day 25 for deposit exposed to sunlight (Table 2). Similarly, LC_{50} of cypermethrin was increased to 37.58 ppm and 41.69 ppm for deposit of 33 days under shade and 29 days exposed to sunlight, respectively (Table 2).

It was observed that the deterioration in the toxicity of fenvalerate and cypermethrin deposits took place quicker where the treated petridishes were exposed under sunlight than the shade. The persistence of both insecticides was lower under 18h sunlight and 16h shade condition per day as compared to exposure to continuous 24h shade conditions. The present findings are in accordance with the findings of Guillebeau *et al.,* [7] who reported efficacies of flucythrinate and tralomethrin for boll weevil were rapidly and severely impaired during a sunny period when daily high temperature averaged over 37^{o}C; cyhalothrin, cypermethrin and esfenvalerate were impaired to a lesser degree, cyfluthrin was unaffected. Cole *et al.,* [5] also found tralomethrin(0.05 μg/cm^{2}) to be completely degraded in 5 d on cotton leaves in sunlight, whereas 37% of cypermethrin (0.05 μg/cm^{2}) could be recovered after 10 d. Several other workers pointed out that synthetic pyrethroids are more photostable but still undergo a variety of photolytic reactions [9-11, 14].

The results obtained in the present study find further support from the reports on the other groups of insecticides. Lindquist *et al.,* [12] reported that an exposure of DDT on glass surface to both ultraviolet and sunlight had reduced the effectiveness of insecticide, as was shown by the increased time required to have knockdown of house flies. Reduction in the toxicity of DDT deposits on glass plates to house flies was also obtained when exposed to sunlight [4]. Almost parallel results were obtained by Srivastava*et al.,* [19]. Bullock [3] found that persistence of many insecticides under Kenyan conditions, where there was intense ultraviolet radiation and high temperature, had important bearing of pyrethrum for control of thrips. Singh and Kavadia [18] reported that the deterioration in toxicity of carbaryl, endosulfan and malathion was quicker when treated surfaces were exposed to sunlight than kept in the shade. They further observed that the dissipation of insecticides was faster when the treated surfaces were subjected to 8 hours sunlight and 16 hours shade per day than when subjected to continuous 24 hours shade condition. Baloda and Gupta [2] found that acephate residues on fruits of tomato plants in total shade dissipated to below detectable level (BDL) in 18 days, whereas BDL reached after 15 and 12 days when plants were kept for 4-5 and 8-9 hours in sunlight.

The rapid reduction in the residual toxicity and persistence of fenvalerate and cypermethrin deposits exposed to sunlight can be attributed to increased volatilization, degradation of insecticides or both. Guillebeau *et al.,* [7] also ascribed the same reason of volatility, degradation of the compounds, or both for the differential reduction in pyrethroid efficacy. Besides this, Matsumura [13] suggested that sunlight is the single most important physical factor influencing the residual fate of pesticide under field conditions, and Taylor *et al.,* [20] reported that the rate of volatilisation is directly related to the input of solar radiation. Photodegradation of pyrethroids by sunlight has been documented by severalworkers [9-11, 15]. Holmstead *et al.* [9] found that differences conferring varying levels of photostability. Similar findings of greater loss of insecticides under sunlight because of enhanced volatilization or decomposition or both has also been reprted by several workers for other groups of insecticides [16, 17].

Table 1: Residual toxicity of cypermethrin and fenvalerate on glass surface to *Callosobruchuschinensis*(Linn.) adults under sunlight and shade factors

Factors	Days after treatment	Percent corrected mortality							
		Cypermethrin Concentrations (ppm)				Fenvalerate Concentrations (ppm)			
		4.0	**8.0**	**16.0**	**control**	**40.0**	**80.0**	**160.0**	**control**
Sunlight	1	85.0	96.67	100.00	0.00	90.00	100.0	100.0	0.00
	5	70.53	91.58	100.00	5.00	67.35	92.86	100.0	1.67
	9	46.94	82.65	94.90	1.67	43.33	78.33	96.67	0.00
	13	28.33	56.67	86.67	0.00	21.67	53.33	90.00	0.00
	17	13.27	33.67	72.45	1.67	7.37	28.42	71.58	5.00
	21	5.00	15.00	53.33	0.00	1.67	8.33	50.00	0.00
	25	1.08	6.45	26.88	6.67	0.00	3.06	20.41	1.67
	29	0.00	1.67	11.67	0.00	0.00	0.00	5.00	0.00
	33	0.00	0.00	3.33	0.00	-	-	-	-
Shade	1	85.00	96.67	100.00	0.00	90.00	100.00	100.00	0.00
	5	73.33	93.33	100.00	0.00	73.33	95.00	100.00	0.00
	9	56.70	84.54	96.91	3.33	50.00	85.56	97.78	10.00
	13	40.21	69.07	92.78	3.33	33.67	67.35	94.90	1.67
	17	27.29	48.28	85.06	13.33	17.20	46.24	86.02	6.67
	21	11.67	31.67	70.00	0.00	5.00	21.67	65.00	0.00
	25	5.00	16.67	53.33	0.00	1.08	8.60	38.71	6.67
	29	1.67	6.67	36.67	0.00	0.00	3.33	20.00	0.00
	33	0.00	3.06	15.31	1.67	-	-	-	-

Table 2: Toxicity of fenvalerate and cypermethrin deposits on glass surface to *Callosobruchuschinensis* (Linn.) exposed to sunlight and shade factors.

Factors	Days after treatment	LC_{50} (ppm)	
		Cypermethrin	**Fenvalerate**
Sunlight	1	1.72	*
	5	2.61	29.51
	9	3.94	45.71
	13	6.68	70.80
	17	10.47	112.20
	21	16.60	117.83
	25	26.91	278.61
	29	41.69	*
	33	*	**
Shade	1	1.72	*
	5	2.39	26.61
	9	3.39	39.81
	13	5.07	55.60
	17	7.59	80.35
	21	11.04	128.83
	25	16.14	194.98
	29	23.71	281.84
	33	37.58	**

LC_{50} (ppm): Concentration in ppm to give 50 percent kill

* Deposit gave 100.00 or 0.00 percent mortality at two concentrations hence LC_{50} could not be calculated.

** No observations.

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