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The Rate of Loss of DDT

[2. 2-bis (p-Chlorophenyl) 1, 1, 1,-Trichloro-ethane] deposits under field conditions*

PART IV

By

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Introductory: The very scanty information available in literature to indicate the rate at which deposits of DDT disappear either under field or laboratory conditions and lose their toxicity is very contradictory in character. Whereas Fleming (1944) reported that one spraying would be sufficient to prevent attack by Japanese beetle for one season, Gunther (1245), reported that under the climatic conditions of California, DDT deposits lost their toxicity rather quickly. A systematic study on a field scale was made by Gunther (1946), using a variety of preparations and analysing the deposits at intervals. Biological tests also appear to have been carried with the residual deposits but the details were not reported.

Experimental: To study the rate at which deposits of DDT decrease under field conditions, 1·0% DDT emulsion prepared by using benzene as solvent were deposited at intervals of 1, 7, 13, 21 and 28 days respectively on undetached apple leaves of known area. The insecticide was applied with a micropipette at the rate of 5 mgm. per 100 sq. cm. (i.e. 50 micrograms per 1 sq. cm.) and spread uniformly. At the end of the experimental period leaves carrying deposits of the same age were collected separately and a portion washed with benzene at the rate of 6 c. c. per leaf and analysed chemically. The other portion (of leaves) was used for testing its biological activity, employing *Tribolium confusum* Duv (Satyanarayana, 1951) as the test insect.

Climatic conditions prevailing during the experimental period and other data are presented in Table I. There was a rainfall of 1·67" during the experimental period.

Discussion: Deposits that are 1, 13, 21 and 28 days old only are considered. The 7 days old deposft was ignored since almost immediately after deposition there was a shower, and this was clearly indicated by the lower recovery values. Analogous to the deposit which is one day old

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under field conditions, a separate trial was made in the laboratory using detached leaves. A comparison of these two sets of values gives an idea of the loss that is likely to take place in the field and under the existing climatic conditions. Under laboratory conditions out of 5·0 mgm. of DDT deposited, 3·52 mgm. i.e. 68·4% was recovered. A similar deposit under field conditions gave only 64·4% recovery, i.e. 3·22 mgm. of DDT. This 4·0% difference (68·4 — 64·4% = 4·0%) noticed between the two sets of recovery values evidently accounts for the loss that had taken place under field conditions. These results also show, that when properly conducted, field trials could be as accurate as laboratory tests, and any fluctuations noticed in the values of the former could be relied upon as giving a true picture of the effect of climatic, seasonal and other factors then prevailing.

It would appear from a perusal of the results in Table I, that out of every 100 parts DDT deposited on apple leaves, 68·4 parts are recovered after 24 hours even under laboratory conditions, which indicates that the rest (31·6 parts) is absorbed by the leaf tissue and confirms the observations already made by Satyanarayana (1951-b). These 68·4 parts that are on the surface get reduced to 64·4 parts in 24 hours, 46·1 parts in 13 days, 39·7 parts in 21 days and 37·6 parts in 28 days by weathering action.

Calculating as a percentage, if the original 68·4 parts that are on the surface represent 100, then the recoveries obtained during the subsequent rounds will be 94·1, 67·4, 58·1 and 54·9 respectively (Col. 6, Table I). The rate of loss of deposits would, therefore be 5·9% in 24 hours, 32·6% in 13 days and 45·1% in 28 days. (Col. 7, Table I).

Plotting the values of deposits found at various rounds against the logarithm of days a straight line graph was obtained. (Chart I). In an experimental period of 28 days when there was a rainfall of 1·97", the loss was 30·8 mgm. (68·4 — 37·6 = 30·8) or roughly 1 mgm. per day. When considered as loss per sq. cm. of leaf area, out of the 5·0 mgm. originally spread on 100 sq. cm. only 3·4 mgm. (i.e. 34 micrograms per 1·0 sq. cm.) were left on the surface which was reduced to 1·88 mgm. (or 18·8 micrograms per 1 sq. cm.) on the last day of the experiment. The loss, therefore, per sq. cm. of leaf surface in the 28-day period was 15·2 micrograms. Gunther (1946) in similar studies reported a loss of 20 micrograms per sq. cm. in a period of 85 days under Californian conditions.

Tested biologically, the washed leaves gave no kill whereas the unwashed ones gave nearly 100% kill in every case. Even after 28 days there was a residual deposit of 1·88 mgm. per 100 sq. cm. of leaf area (i.e. 18·8 micrograms per sq. cm.) which is much more than what is needed to kill by contact action an insect like *Tribolium* [Satyanarayana, 1951(a)].

It is obvious from the foregoing that, (1) there is a close logarithmic relationship between the age of deposits and the rate at which they are lost, and (2) the deposits on leaves treated with 1% preparations retain their insecticidal activity for more than a month. In practice, however, where agricultural crops are concerned the use of such high concentrations is rare, but this high percentage was purposely chosen to make the estimation of the deposits possible and see whether any relationship could be established between the rate of loss of deposits and their age.

Having obtained the necessary preliminary information, attention was next directed to study the rate of loss of deposits when applied in concentrations that are usually employed in field practice. Accordingly, DDT emulsions of 0·2%, 0·1%, 0·05%, 0·025% and 0·0125% concentration were prepared and undetached apple leaves each measuring 20 sq. cm. in area at stated intervals were dipped individually. for a period of 10 seconds, allowed to dry and drain. All the leaves thus treated were collected at the end of the experiment and the toxicities of residual deposits tested biologically (Table 2).

A perusal of the results (Table 2) show again that, (1) the toxicity of deposits decreases with decrease in concentration, and, (2) the same preparation loses its toxicity with age (vide results of 0·2% emulsion). Represented graphically, the probits for the 0·2% preparations fall in a line when plotted against log of days (chart 2), and the line runs almost parallel to that found in chart I. It is evident that when the rate of loss of deposits is studied either by chemical or by biological means there is a close paralielism, and if suitable chemical methods could be found for estimating the residues, they could be easily correlated with their biological performances.

Chart.1
D.D.T deposits found at different rounds
(TABLE I COL.5)

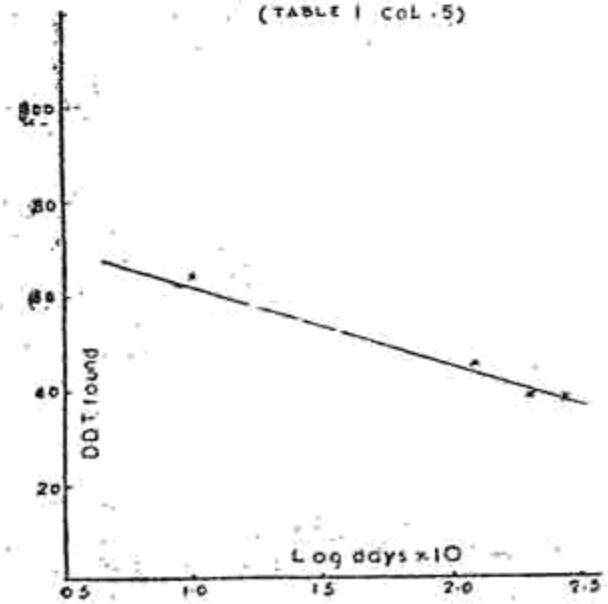
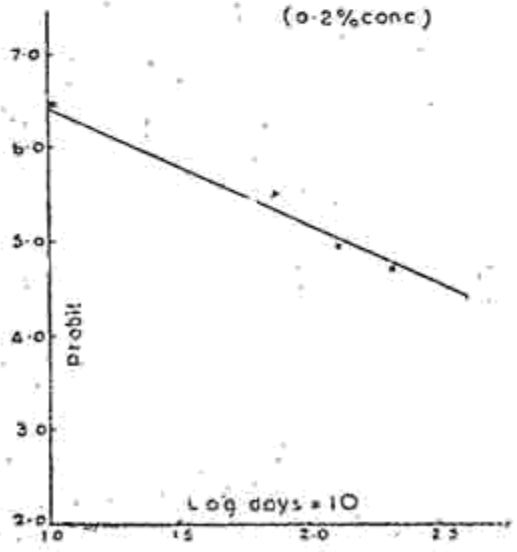


Chart.2
Relation between age of deposits & their toxicity
(0·2% conc)



Barring the 0·2% preparation, all the rest seem to have lost their toxicity within about a week's time under the existing climatic conditions. Certain limitations inherent in such tests must, however, be borne in mind while perusing such results like the variation in the toxicities of poisons to insects, the test insect used, its age etc. Again, in the laboratory tests, the insects are always in contact with the treated surface which is not so under field practice. Accordingly, with the same pest higher dosages of poison might be needed under field conditions to give a similar response.

Summary: Studying the rate of loss of DDT deposits it was found that there was a close parallellism between the chemical and biological tests, and if suitable methods could be found for evaluating the former in micro-amounts they could be properly correlated with the latter. The rate of loss is dependent upon the climatic and other factors.

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TABLE I

Effect of Weathering on DDT Deposits. 1% DDT Emulsion in Benzene Periodically Deposited on Apple Leave
Benzene :— 3% ; Emulsifier :— Soap, 0·5%.

Round of depositing	Age of deposit when analysed days.	DDT deposited on 100 sq. cms. of leaf (mgm.)	DDT recovered (mgm.)	% DDT recovered	% DDT recovered	% DDT recovered	Biological Tests (*Tribolium confusum*) Washed leaves.		Unwashed leaves.		Weather Data			
							Insects tested	% killed	Insects tested	% killed	Date (1947)	Rain fall.	Max. tem.	Minimum temperature.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
No. 1	·28	5·0	1·879	37·58	54·9	45·1	75	0	75	95·9	June 18	·06	72	49
											,, 19	·09	71	50
											,, 20	·02	64	52
											,, 21	T*	73	53
No. 2	21	5·0	1·986	39·72	58·1	41·9	75	0	75	100·0	,, 22		67	52
											,, 23		69	42
											,, 24		75	43
No. 3	13	5·0	2·305	46·10	67·4	32 6	75	0	75	96·0	,, 25		76	51
											,, 26	T*	84	46
No. 4	7	5·0	1·807	36·14	...	...	75	0	75	96·1	,, 27	·99	84	64
											,, 28	·17	84	58
											,, 29	...	70	58
No. 5	1	5·0	3·220	64 40	94·1	5·9	...	...	...	...	,, 30	·02	68	57
No. 6	1 (Lab)	5·0	3·420	68·40	100	0	75	0	...	...	July 1	·03	69	51
											,, 2	T*	74	55
											,, 3		76	54
											,, 4	·05	75	52
											,, 5		65	45
											,, 6	·08	68	46
											,, 7	·02	69	54
											,, 8	·10	61	48
											,, 9	T*	67	50
											,, 10	·24	61	56
											,, 11		66	51

*T = Trace

TABLE I—*cont.*

Round of depositing	Age of deposit when analysed days.	DDT deposited on 100 sq. cms. of leaf (mgm.)	DDT recovered (mgm.)	% DDT recovered	% DDT recovered	% DDT recovered	Biological Tests (*Tribolium confusum*) Washed leaves		Unwashed leaves.		Weather Data			
							Insects tested	% killed	Insects tested	% killed	Date (1947)	Rain fall.	Max. tem.	Minimum temperature
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
											July 12		70	45
											,, 13	T*	78	49
											,, 14		80	55
											,, 15		79	57
											,, 16		...	58
											Total rainfall ...		1·67 inches	

*T = Trace

TABLE II

Effect of Weathering on the Toxicity of DDT Deposits—Dipping and Draining of Leaves.
Emulsifier used :— Product MB 320 at 0·05%. Benzene as solvent :— 10%

Concentration of emulsion	Age of deposit days	No. of insects tested	No. of insects dead	Percentage of dead insects	Weather Data			
					Date	Maximum temperature °F	Maximum temperature °F	Rainfall in inches.
					1947			
0·0125	22	90	0	0	July 29	83	65	
	14	90	0	0	,, 30	69	59	
	8	91	2	2	,, 31	73	61	
	1	90	60	67·7	Agust 1	79	52	0·05
0·025	22	90	0	0	,, 2	74	58	
	14	90	0	0	,, 3	78	55	
	8	91	1	1·1	,, 4	76	51	T
	1	93	49	52·7	,, 5	68	55	T
					,, 6	73	54	
0·05	22	89	0	0	,, 7	69	49	
	14	90	0	0	,, 8	75	44	
	8	89	23	25·8	,, 9	73	45	
	1	90	59	65·6	,, 10	69	49	
					,, 11	73	51	
0·10	22	88	0	0	,, 12	74	52	
	14	92	0	0	,, 13	78	51	
	8	90	18	20·0	,, 14	78	55	
	1	88	77	87·6	,, 15	82	59	T
					,, 16	86	57	
0·20	22	90	34	37·7	,, 17	85	59	
	14	90	40	44·4	,, 18	83	59	
	8	92	63	68·5	,, 19	78	66	
	1	87	80	92·0	,,			
Controls.	...	75	0	0	Total.			0·05

T—Trace.