250e

A Comparison of Evaporation Rates and Toxicity to House Flies of Lindane and Lindane-Chlorinated Polyphenyl Deposits[1]

CHING-HSI TSAO, W. N. SULLIVAN, and IRWIN HORNSTEIN, *Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture*

Methods of increasing the residual persistance of insecticides have been reported by many authors. Block (1948) and Lindquist *et al.* (1945) reported that the residual effectiveness of DDT was prolonged when it was applied in resins and paints. Van Tiel (1952) increased both the effective period and the toxicity of a DDT deposit on a glass surface by the addition of a small amount of coumarone resin to a DDT solution in kerosene.

Sullivan & Hornstein (1953) found that a lindane residue remains toxic longer when it is incorporated with a chlorinated polyphenyl. They suggested that the chlorinated polyphenyl prevents the crystallization of the lindane, and cuts down the vapor pressure of the lindane in the mixture (Hornstein & Sullivan 1953). Means of prolonging the residual effectiveness of lindane were particularly needed, because of the rapid evaporation of this insecticide. A study was therefore undertaken at Beltsville, Md., from June to November 1952, to measure the loss of weight, through evaporation, of lindane and lindane-chlorinated polyphenyl deposits on glass surfaces. Also the residual toxicity of such deposits was determined aginst house flies, *Musca domestica* L.

MATERIALS TESTED.—The test solutions were made up by dissolving lindane and lindane-chlorinated polyphenyl in carbon tetrachloride. The chlorinated polyphenyl used in all this work is available commercially as Aroclor 5460.

RATE OF EVAPORATION.—To determine the rate of evaporation of deposits of lindane, chlorinated polyphenyl, and equal parts of lindane and chlorinated polyphenyl, test solutions were delivered from a burette onto cover glasses 0.72 inch in diameter. For convenience in weighing, only cover glasses weighing less than 98.5 mg. were used. Individual cover glasses were weighed before and after the deposition of chemicals on a precision balance that read to 0.01 mg. on the vernier scale.

The cover glasses, with the side having the chemical deposit up, were placed in a cupboard, 10 by 25 by 31 inches, in the laboratory. This cupboard had two sliding doors, which were closed during the aging of the deposits to minimize the accumulation of dust. However, to avoid setting up an equilibrium between the lindane in the air and the lindane on the cover glasses, the cupboard was not made airtight. The weights of the cover glasses were checked from time to time.

The rate of evaporation was determined from the loss in weight of the deposits. The weight of a deposit was calculated by subtracting the weight of a cover glass from the weight of the cover glass with its deposit. The initial weight was determined on the fourth day after the chemical was deposited, because it was found that there was a rapid initial loss in weight in the chlorinated polyphenyl and lindane-chlorinated polyphenyl deposits, presumably owing to evaporation of the last traces of solvent.

The rates of evaporation of lindane, chlorinated polyphenyl, and lindane-chlorinated polyphenyl deposits are given in figure 1. There is a straight-line relationship between the loss in weight of all deposits and time. On the glasses with deposits of lindane alone an initial deposit of 1.00 mg., corresponding to 300 mg. per square foot, lost half its weight in 23 days, and completely evaporated in about 50 days. The deposits on two out of five cover glasses could be barely seen on the 45th day. An initial deposit of 1.31 mg., corresponding to 390 mg. per square foot, lost half its weight in 27 days and completely evaporated in about 60 days. There were only very light and spotted deposits on the 59th day.

On the glasses with the lindane-chlorinated polyphenyl and chlorinated polyphenyl deposits, the rate of evaporation was much lower than on the glasses containing lindane alone. On the 149th day

[1] Presented at the meeting of the American Association of Economic Entomologists at Philadelphia, Pa., December 15–18, 1952.

DEPOSITION EXHIBIT Papageorge-anc 20-ID 8-28-81 PENGAD-Bayonne, N. J.

WATER_PCB-SD0000039119

the respective losses were 13.5 and 9.3 per cent.

On the glasses coated with lindane-chlorinated polyphenyl, needle-like crystals were abundant for the first 15 days, but the quantity decreased thereafter.

TOXICITY TO HOUSE FLIES.—To test the toxicity of these deposits against house flies, solutions were poured onto 8- by 10-inch glass plates and the plates were agitated to get a uniform deposit. The plates thus coated were placed in a vertical position on a rack in an insectary and aged 1 to 22 weeks. The insectary was well ventilated, with temperature and moisture conditions similar to those outdoors from June to November.

Two sets of about 100 flies 3 to 4 days old were exposed to each plate for 10 minutes by confining them under petri dishes 3.5 inches in diameter. After exposure the two sets of flies were transferred to separate cages and furnished with a cotton ball soaked with milk. Mortality counts were made after 20–22 hours. Moribund flies were considered as alive.

In one series of tests, deposits of 10 and 25 mg. of lindane, 10 mg. of lindane plus 20 mg. of chlorinated polyphenyl, 25 mg. of lindane plus 50 mg. of chlorinated polyphenyl, and 25 mg. of chlorinated polyphenyl per square foot were tested. In another series, deposits of 0.05 to 2.0 mg. of lindane per square foot, with and without chlorinated polyphenyl, were tested.

In the first series of tests there was a rapid loss of toxicity to flies at both dosages of lindane. However, with the addition of chlorinated polyphenyl 10 mg. of lindane was effective for at least 9 weeks, and 25 mg. of lindane for 22 weeks.

There was no mortality of flies exposed to the chlorinated polyphenyl alone at 25 mg. per square foot for 10, 25, and 50 minutes.

The results of the second series of tests are given in table 1. There was no noticeable mortality of flies exposed for 10 minutes to 0.05 and 0.1 mg. of lindane per square foot with or without chlorinated polyphenyl. However, 0.3 mg. of lindane with chlorinated polyphenyl and 0.5 mg. of lindane alone gave high mortalities. The lindane-chlorinated polyphenyl mixture of the 2-mg. dosage was highly toxic for at least 3 weeks.

DISCUSSION.—Deposits of lindane, chlorinated polyphenyl, and lindane-chlorinated polyphenyl on glass surfaces evaporated at widely different rates (Fig. 1).

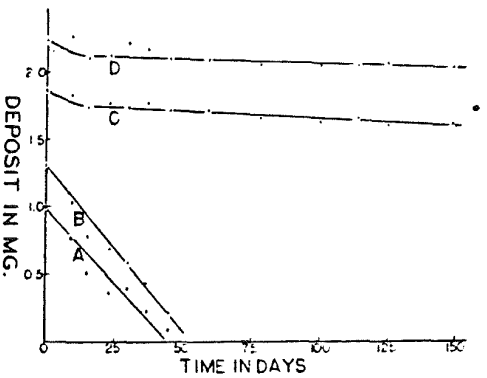

FIG. 1.—Loss of weight of deposits of lindane (A and B), chlorinated polyphenyl (D), and lindane-chlorinated polyphenyl (C) on glass surfaces.

Lindane crystals lost weight rapidly because of their relatively high vapor pressure. Deposits of 300 to 390 mg. of lindane per square foot completely disappeared in about 50 to 60 days.

The lindane-chlorinated polyphenyl mixture evaporated at a rate slightly higher than that of chlorinated polyphenyl but much lower than that of lindane. It lost 13.5 per cent of its weight in 149 days. If this rate of evaporation were maintained, it would take more than 500 days to lose half its initial weight.

The residual toxicity of lindane is prolonged markedly when it is incorporated with chlorinated polyphenyl. A deposit of 25 mg. of lindane plus 50 mg. of chlorinated polyphenyl had a high toxicity against house flies for more than 5 months, whereas 25 mg. of lindane alone was toxic only for a little over 1 week.

Table 1.—Toxicity to house flies of lindane and lindane-chlorinated polyphenyl (1:2) residues of different ages. Time of exposure was 10 minutes.

LINDANE DOSAGE (MG. SQ. FT.)	PER CENT MORTALITY IN 20 TO 22 HOURS						
	Lindane		Lindane-Chlorinated Polyphenyl				
	Minutes		Minutes		Weeks		
	20	60	20	60	2	8	5
0 (check)	—	—	2.1	3.8	2.2	3.6	2.0
0.05	8	—	3	—	—	—	—
.1	8	—	6	—	—	—	—
.3	35	—	99	—	10[1]	—	—
.5	—	97	—	100	—	5	1
1.0	—	100	—	100	30	28	0
2.0	—	100	—	100	81	100	1

[1] Residue 1 week old.

WATER_PCB-SD0000039120

Even 2 mg. of lindane plus 4 mg. of chlorinated polyphenyl had a longer residual effect (at least 8 weeks) than 25 mg. of lindane alone.

The increase of residual toxicity of lindane when incorporated with chlorinated polyphenyl can be explained by its lower vapor pressure, and consequent slower evaporation, and the slow diffusion of lindane molecules from the body of this mixture to its surface.

The difference in mortalities of flies exposed to deposits of 0.3 mg. of lindane with and without chlorinated polyphenyl suggests that the chlorinated polyphenyl may have a synergistic effect. More work should be done on the synergistic action of chlorinated polyphenyl and on its formulation for practical applications.

SUMMARY.—The rate of evaporation of deposits of lindane, chlorinated polyphenyl, and lindane-chlorinated polyphenyl on glass surfaces was determined by periodical weighings of the residues.

Lindane deposits lost weight rapidly. However, with the addition of an equal part of chlorinated polyphenyl, the rate of lindane evaporation was cut down markedly.

Chlorinated polyphenyl itself had no toxic effect on house flies (*Musca domestica* (L.), but when incorporated with lindane it increased markedly the residual toxicity of that insecticide. There is some indication that chlorinated polyphenyl may have a synergistic effect with lindane

LITERATURE CITED

Block, S. S. 1948. Insecticidal surface coatings. Soap and Sanit. Chem. 24(2): 138–141, 171.

Hornstein, I., and W. N. Sullivan. 1953. The role of chlorinated polyphenyls in improving lindane residues. JOUR. ECON. ENT. 46. (in press)

Lindquist, A. W., Madden, A. H., Wilson, H. G., and Knipling, E. F. 1945. DDT as a residual-type treatment for control of house flies. JOUR. ECON. ENT. 38: 257–61.

Sullivan, W. N., and Hornstein, Irwin. 1953. Chlorinated polyphenyls to improve lindane residues. JOUR. ECON. ENT. 46: 158–9.

Van Tiel, N. 1952. Improvement of the residual toxicity of DDT solutions by the addition of coumarone resin. Bul. Ent. Res. 43: 418–9.

The Effect of Meadow Management on the Abundance of Meadow Spittlebugs

D. R. KING[1] and C. R. WEAVER, *Ohio Agr. Expt. Station, Wooster*

Observers in various states have reported that infestations of nymphs of the meadow spittlebug, *Philaenus leucophthalmus* (L.), vary from field to field and from locality to locality. Biological and ecological studies in Ohio have disclosed information on the relationship of cultural practices to the seasonal behavior of meadow spittlebug adults. The fall behavior of the adult spittlebug determines the location and extent of succeeding nymphal populations. The results of this study aid in explaining the variations in infestations that occur in different meadows.

In areas like New Jersey and Maryland where the summer seeding (August) of alfalfa is practiced, older stands have been reported as being more heavily infested than first harvest year stands. Red clover, usually seeded in grain in the spring, has been observed to support high nymph populations in the first harvest year. Medler (1951) in Wisconsin and Gyrisco *et al.* (1952) in New York were unable to correlate spittlebug populations and age of stand. Weaver (1951) reported that in Ohio spittlebug nymphs usually do not appear in economically important numbers in second and third harvest year meadows.

Data obtained in 1950, 1951, and 1952 in a number of meadows of varying ages support the assertion that in northern Ohio populations are largest in first harvest year meadows. Several comparisons of spittlebug nymph populations in first, second, and third year meadows are presented in table 1. In each instance adjacent fields or replicated plots in agronomic rotation experiments were compared.

[1] Now Asst. Professor, Dept. of Entomology, Texas A & M College.

WATER_PCB-SD0000039121