

EFFECT OF SOME OF THE CLIMATIC FACTORS ON RESIDUES
OF THE PHOSPHORUS INSECTICIDE, MALATHION

by

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INTRODUCTION AND REVIEW OF LITERATURE

Recent developments in the widespread use of organic insecticides applied to the crops in order to control numerous insects have necessitated the evaluation of their residual effectiveness against these insects. Frequently the degree of control obtained depends, to a large extent, upon residual toxicity of the insecticide deposits on plant surfaces with which these insects come in contact from time to time.

Many of the organic insecticides are also highly toxic to mammals. The widespread applications and long-lasting residual action of some of these materials have created many problems regarding the consumption of treated plants by man and animals. In applying residual insecticides, the safety of man and animal from spray residues on food crops must be considered.

Earlier work on DDT residues has suggested that temperature, moisture, and light are the important factors of physical environment that have influence on residual toxicity.

Graham et al. (1945a) reported that DDT is greatly affected by sunlight.

Fleck (1944) attributed the loss of DDT residual toxicity due to evaporation.

It has been postulated by Harman (1945) that weathering or the possible breakdown of DDT into a less toxic form is responsible for the loss of its residual toxicity in the field.

Grunther et al. (1946) reported that DDT deposits, under field conditions, showed a steady and gradual decline in the

quantity of deposit over an 86-day period. Heavy rains during the latter part of that year had no demonstrable effects upon the magnitude of the deposits. These authors did not distinguish between the removal of DDT deposits by weathering and by chemical decomposition.

Vendramini (1947) found that exposing a thin layer of DDT on a glass plate to ultraviolet rays for one hour caused the same inactivation (to Drosophila melanogaster) as thirty days of natural sunlight.

Continued investigations have been made on climatic factors affecting the toxicity of certain insecticides.

The effect of temperature, humidity, sunlight, dew and rain on insecticide toxicity has been reported by Gaines and Dean (1949,1950) and Gaines and Mistic (1951,1952).

Mistic and Gaines (1954), working on the effect of weather factors on the toxicity of certain insecticides, found that wind was not an important factor in reducing the toxicity of aldrin because aldrin lost its toxicity very rapidly even in the absence of wind. The toxicities of dieldrin and endrin were reduced appreciably by increased wind. An increase in wind movement was found to slightly decrease the toxicity of insecticides, at least within the range of wind velocities tested. The effect of wind was not dependent on the dosage of insecticides applied in these tests.

The persistence of DDT on living leaves and on glass plates was investigated by Ward and Burt (1950). The DDT

content of the deposits was estimated chemically. At lower range of air temperature of 10-21°C. (50-69.8°F.) there was a loss, after 37 days, of about one-third of the DDT from suspension-deposits applied at the rate of 2 ug. per sq. cm. to either leaves or plates. For deposits on leaves, the losses of DDT indicated by bioassay were about equal to those found by chemical estimation, but for deposits on plates the toxicity after exposure was markedly greater than was to be expected from the remaining amount of DDT. In another experiment at the same temperature range, but with lower rates of deposit, loss of DDT occurred more rapidly; the lower the rate of deposit, the greater the percentage of DDT lost.

Fahey et al. (1952), in their studies on longevity of parathion and related insecticides in spray residues, found that the rate of loss of parathion deposits on apple foliage during periods of uniform temperature and in the absence of rainfall is a function of the log of the time elapsed. They showed that the difference in temperature accounted for much of the loss of the insecticide residue at high temperatures, compared with less at lower temperatures.

Mistic and Martin (1956) reported the results of an investigation conducted for the purpose of finding the effect of sunlight and other factors on the toxicity of certain insecticides. The effectiveness of parathion or endrin in controlling cotton leafworm was reduced to a greater extent than that of toxaphene or calcium arsenate during a 24-hour exposure

of treated plants to natural conditions in the absence of rainfall.

Some organic phosphorus insecticides such as malathion and parathion are weak anticholinesterases but are converted to powerful inhibitors ("activated") by certain enzyme systems.

Metcalf and March (1956) reported that thionophosphate insecticides such as parathion and its methyl analogue O,O-dimethyl O-p-nitrophenyl thionophosphate have been shown to kill insects by inhibition of the cholinesterase enzyme. However, when highly purified, these insecticides do not inhibit insect cholinesterase in vitro to any appreciable extent. It has been demonstrated that highly purified thionophosphates are converted to toxic anticholinesterases, presumably the oxygen analogues by an enzyme system present in insects and mammals.

O'Brien (1956), studying the effect of malathion on flies and roaches, found that it produced a marked initial inhibition of the cholinesterase of poisoned flies.

March et al. (1956) studied malathion metabolism in the roach, to which the compound is toxic. Chromatography of the metabolic products showed only two spots. One of these was probably given by malathion and the P-O analogue (O,O-dimethyl S-(1,2-bis-carboethoxy)-ethyl phosphorothiolate) which were not resolved.

There is enough evidence to show that certain residual toxicants do not give as much protection against field pests as when used against pests treated by artificial means in the

laboratory, where the physical environment is more uniform. This has led many investigators to study the influence of various factors of environment on residual effectiveness.

The tests reported herein were conducted to obtain additional information regarding the effect of environmental factors, like wind velocity and high temperature, on the amount and nature of losses of an organic phosphorus insecticide, malathion. The present work includes a series of experiments designed to evaluate the relative importance of various wind velocities and temperatures which largely remove the malathion residues.

To the writer's knowledge very little work has been done in the past to study, chemically and quantitatively, the magnitude of loss of phosphorus insecticide residues exposed to controlled conditions of air velocity and temperature.

MATERIALS AND METHODS

Technical malathion (O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate) obtained from the American Cyanamid Company, Stamford, Connecticut, was used.

Malathion was selected for this investigation since it was the first organophosphorus insecticide developed with low mammalian toxicity, a property which has led to its widespread use today. The general toxic hazard of malathion apparently approaches that of DDT, Anonymous (1956).

The oxygen analogue of malathion or compound 4389 (0,0-diethyl S-(1,2 dicarbethoxyethyl) phosphorothiolate) was also used.

It is assumed to be experimental insecticide, technical grade which was also obtained from American Cyanamid Company.

Wind Tunnel Apparatus

The equipment consisted primarily of a plate chamber, in which the glass plates coated with insecticide are placed, a constant temperature air-tight box, and a blower for the purpose of circulating the air (Plate I).

The inside dimensions of the constant temperature air box were 140 cm. by 65 cm. by 80 cm. The box was insulated by means of an asbestos lining with a waterproof coating of tygon.

The plate chamber was constructed of galvanized iron and was 40 cm. high, and 11.5 cm. square. It was connected to the constant temperature chamber by means of a pipe measuring 7 cm. in diameter. The air was circulated through the chamber from bottom to top.

The plate chamber was so constructed that three glass plates could be placed in a vertical position in each of three columns of the chamber. The columns were staggered so as to prevent the restriction of air from any one plate. The ends of the chamber were tapered down to fit the connecting pipe so as to hold turbulences within the chamber to a minimum.

The temperature of the system was controlled by an electronic relay in conjunction with a thermostat which controlled the heater in the box.

The velocity of the air was controlled by a manually operated valve at the entrance of the constant temperature chamber and was measured with a velometer connected to the pipe between the plate chamber and the fan.

The temperature and humidity within the plate chamber were measured by means of thermocouples. Three thermocouples were attached to the test chamber to measure the temperature for different columns. One was placed at the bottom and two were placed at the post chamber connection. One of the post chamber thermocouples was a wet-bulb and dry-bulb thermometer. The temperatures were determined with a Leed's and Northrup Potentiometer.

Insecticide Exposure Surfaces

The only type of surface used in this work was glass. Ten cm. square glass plates were specially cut to fit in the plate chamber.

Chemical Method

The colorimetric determination, described by Morris and Averell (1954), was employed for estimating the residues of malathion on the glass plates.

Insecticide Application. A solution of malathion in

carbon tetrachloride was prepared so that one milliliter contained 1000 ug. of the toxicant.

A known volume of the solution was measured with a volumetric pipette and applied evenly over the plate surface. The solvent was allowed to evaporate.

The quantity of malathion in the prepared solution was estimated chemically every time a new solution was prepared.

The loss of the insecticide was studied under varying conditions of wind velocity, various time exposures in the air stream, temperature, and concentration of the insecticide in the wind tunnel. The relation between these various factors was studied at the velocity of 5.65, 11.3 and 16.95 miles per hour.

The effect of the wind at the above velocities was checked on two concentrations of 1000 and 2000 ug. of malathion per plate. Four exposure times used were 4, 8, 24, and 48 hours.

Loss under room conditions with no air circulation was investigated by subjecting glass plates coated with the insecticide to the room atmosphere and was conducted on a laboratory shelf protected from air currents and sunlight.

Exposure times and temperatures of the plates in and out of the chamber were identical to show the magnitude of loss due only to wind effect. Temperature of the room where these experiments were conducted was $80^{\circ}\text{F.} \pm 4^{\circ}$. Each experiment was replicated three times. Each replicate consisted of three

plates (one from each of the three different columns of the chamber) for one analysis.

Another experiment was conducted under a relatively high temperature which was $110^{\circ}\text{F.} \pm 1^{\circ}$. The main objective for this experiment was to study the effect of wind at high temperature.

Insecticide treated plates were placed inside a well-closed large, thin metal drum 25 cm. in diameter and 30 cm. high. The drum was put in the box, thus subjecting the plates to the effect of temperature alone.

Identification of the Air Degradation Products of Malathion

Chromatographic Methods. The objective of this study was to identify the unknown "air degradation products" of malathion.

Six glass plates were treated with 1000 ug. each, and another six treated with 2000 ug. of malathion per plate. Three plates from each group were subjected to wind at 16.95 m.p.h. for 24 hours at 83°F. The residue from each group was washed with a minimum amount of glass distilled acetone. The bulk of the solvent was reduced by the aid of mild heat and a stream of air.

The remainder of the treated plates were subjected to the same conditions of wind, time, and temperature and the residue was estimated colorimetrically.

The volume of the reduced washings was made up in a volumetric flask so that one microliter contained 2 ug. of the malathion.

The same work was repeated but using 48 hours duration instead of 24 hours.

Spot Test Technique and Rf Values. Technical malathion and the "air degradation products" were examined by paper chromatographic technique similar to that previously described by March et al. (1954), Kaplanis (1954) and Ware (1955). Ascending technique of paper chromatography was employed using 0.5 in. wide strips of Whatman No. 1 filter paper. The mobile solvent was a mixture of ethyl alcohol 75 per cent, one part, acetone one part, and distilled water two parts (by volume).

The solution of either technical malathion or the air degraded products was applied 3.5 cm. from the bottom of the strip in 5 ul. of acetone solution. The point of application was held at a minimum by the multiple application of 1 ul. drops. The various spots were located by developing the chromatograms in $KMnO_4$ reagent.

Spot Test for the Presence of In Vitro Cholinesterase Inhibitors. Cook (1955) described a technique for the detection of in vitro cholinesterase (CHE) inhibitors, in situ, on paper chromatograms. It was shown that under proper conditions of chromatography the inhibitor components of some organic phosphates could be made to migrate away from the original spot and leave no detectable inhibition there. The technique described by the author was used in this work for visual location of in vitro inhibitors in situ on the chromatograms for qualitative test.

Technical malathion, the oxygen analogue of malathion O,O-diethyl S-(1,2 dicarbethoxyethyl) phosphothiolate, and "air degradation product" which was obtained as described before were tested by this technique. In a series of experiments the approximate quantity of each of these compounds spotted onto the paper at the origin was in 10 ul. of redistilled acetone solution.

In other experiments 1 ug. of the oxygen analogue was used to spot the filter papers. Horse plasma was used as source of the CHE enzyme, and acetylcholine bromide served as the substrate.

RESULTS AND DISCUSSION

The corresponding per cent losses of malathion residues from glass plates subjected into the wind tunnel at various wind velocities, for various lengths of exposure time, and under room temperature 80°F . $\pm 4^{\circ}$ are presented in Table 1. Array of mean per cent losses of malathion residues, presented in Table 2, clearly demonstrate that there was a significant difference (at 0.01 level of probability) in the magnitude of malathion-residues losses among the four exposure times for all wind velocities as a whole.

The analysis of variance indicated that there was a highly significant difference in the per cent loss of malathion residues from the glass plates exposed to various wind velocities even at 0.01 level of probability. But, when the array

Table 1. Per cent losses of malathion residues from glass plates subjected to various wind velocities for different exposure times at 80°F. ± 40.1

Time of Exposure (Hours)	5.65 m.p.h.	11.3 m.p.h.	16.95 m.p.h.	Total Residue of Malathion per Plate		
(Hours)	1000 ug:	2000 ug:	1000 ug:	2000 ug:	1000 ug:	2000 ug
	Mean per cent losses					
4	15.76	8.7	19.53	12.23	36.50	19.63
8	30.56	17.16	70.13	44.40	77.03	51.40
24	72.32	58.30	78.97	66.67	84.42	69.33
48	87.46	77.06	88.93	79.40	89.90	79.76

¹ Per cent figures given in the above table are the average of three separate analytical estimations of malathion residues each involving six plates.

Table 2. Array of mean per cent losses of malathion residues from glass plates at various exposure times into the wind tunnel at various wind velocities.

Time of Exposure (Hours)	Mean Per cent Loss
4	18.73
8	* 48.45
24	* 71.67
48	* 83.75

L.S.D. at 0.01 level = 9.81.

* Significant at 0.01 level.

of mean per cent losses of malathion residues from glass plates exposed to the three wind velocities in the wind tunnel was computed and tested for statistical significance at 0.05 per cent level (Table 3), there was apparently no difference in the magnitude of loss of residue exposed to 5.65 and 11.3 m.p.h., and likewise within 11.3 m.p.h. to 16.95 m.p.h. But there was significant difference in the magnitude of residue loss between 5.65 m.p.h. and 16.95 m.p.h.

Table 3. Array of mean per cent losses of malathion residues from glass plates exposed to various wind velocities in the wind tunnel for different exposure times and concentrations.

Wind Velocity (m.p.h.)	:	Mean Percent Loss
5.65	:	22.96
11.3	:	n.s.
16.95	:	* 28.77
		n.s.
		31.75

L.S.D. at 0.05 level = 6.24.

n.s. Not significant at 0.05 level.

* Significant at 0.05 level.

The two-way interaction between exposure time and wind velocity for mean per cent loss of malathion residues from glass plates is presented in Table 4. At all various wind velocities there was a significant difference at 0.01 level of probability between the mean per cent loss of malathion

Table 4. Two-way interactions between exposure time and wind velocity from the mean per cent losses of malathion residues from the glass plates.

Time of Exposure (Hours) :	Wind velocities (m.p.h.)				
	5.65	:	11.3	:	16.95
	Mean per cent losses				
4	12.23	n.s.	15.88	n.s.	28.07
	*		* *		*
8	23.86	n.s.	57.27	n.s.	64.22
	*		* *		*
24	65.31	n.s.	72.82	n.s.	76.88
	*		* *		*
48	82.26	n.s.	84.14	n.s.	84.83

L.S.D. at 0.01 level = 10.750.

n.s. = difference is not significant at 0.01 level.

* = difference is significant at 0.01 level.

residue at various lengths of exposure time. But there was no practical difference in the residue loss at any one exposure time between consecutive velocities but there was a difference between extreme velocities, a fact which is also clearly demonstrated in Table 3.

The losses of malathion residues from glass plates exposed at room atmosphere and protected from air currents are given in Table 5. Although there is no noticeable consistent difference in the magnitude of losses of malathion residues at the two different concentrations at all exposure times, this difference was not significant statistically.

Table 5. Per cent losses of malathion residues from glass plates exposed in a closed air-tight box with no air circulation.¹

Total Residue of : Malathion/Plate :	Per cent Losses at Various Time Exposures			
	4 Hours :	8 Hours :	24 Hours :	48 Hours
1000 mg.	9.9	13.1	15.1	38.0
2000 mg.	4.7	6.5	10.2	26.7

¹ Per cent losses given in the above table are the average of nine separate analytical estimations of malathion residues each involving six plates.

Array of mean per cent losses of malathion residues from glass plates exposed to room conditions and protected from air currents, Table 6, shows that for both concentrations, as a whole exposed for various lengths of exposure time, there was no significant difference between 4 to 8 hours, and 8 to 24 hours. But there was a significant difference (at 0.05 level of probability) between 4 to 48 hours, 8 to 48 hours, and 24 to 48 hours.

On applying the insecticide at different rates, apparently, the lower the rate, the greater the percentage lost in a given time. However, the total loss or the rate of loss was higher for the higher concentration and low for the lower one.

The rate of loss of malathion when deposits were exposed to relatively high temperature of 110°F. ±1° at wind velocity of 16.95 m.p.h., and at two different concentrations, was also studied.

Table 6. Array of mean per cent losses of malathion residues from glass plates exposed in a closed air-tight box with no air circulation.

Time of Exposure (Hours)	:	Mean per cent losses
4	:	7.3
8	:	n.s.
	:	9.8
	:	n.s.*
24	:	12.7
	:	*
48	:	32.4

L.S.D. at 0.05 level = 6.59.

n.s. = difference is not significant at 0.05 level.

* = difference is significant at 0.05 level.

Table 7 demonstrates the per cent loss due to the high temperature and the effect of the velocity of air at 110°F. $\pm 1^{\circ}$.

On comparing the per cent losses of malathion at room temperature (84°F. $\pm 4^{\circ}$) (Table 5) and under the effect of high temperature only (Table 7, columns 2 and 3), it was found that there is a noticeable effect of high temperature which causes more loss (for example, 9.9 vs. 28.6 at 4 hours and 1000 ug).

In the experiment conducted under the combination of temperature and high velocity of air (Table 7), loss of malathion occurred more rapidly under these conditions; and the lesser deposit of 1000 ug resulted in a greater percentage of insecticide lost, especially in the first 4 hour period.

Table 7. Effect of temperature on per cent loss of malathion residue from glass plates. Comparison between per cent loss due to the effect of 16.95 m.p.h. wind velocity at 110°F. and the effect of temperature 110°F. only.

Exposure time :	Temp. 110°F.		16.95 m.p.h. at 110°F.	
	Concentrations		Concentrations	
:	1000 ug.	2000 ug.	1000 ug.	2000 ug.
4	28.6	15.0	85.6	77.2
8	32.6	17.5	91.5	84.1
24	44.1	25.8	100.00	96.00

From the results obtained in the present study it is difficult to generalize as to residue losses over a wide range of variables, since the scope of the experiment is limited only to a few combinations of weathering factors, wind velocity and temperature. However, data presented indicate that either the wind or the high temperature caused a rapid loss of the deposit soon after application but much less during the succeeding hours.

Since neither of two factors when investigated alone was able to eliminate all the residue in a period of 24 hours, it is interesting that the interaction of wind and high temperature is so effective in eliminating malathion residues.

Table 7 shows that 91.5 and 100 per cent of the original deposit was lost in 8 and 24 hours respectively due to the combined action of wind and the relative high temperature. From this discussion we may draw a conclusion that the large

percentage of residue loss due to the interaction of the two weathering components may be very important in eliminating residues of malathion in arid regions or areas of prolonged drought.

Although Table 1 indicates that higher per cent of malathion was lost at the lower concentration, in fact, the quantity of loss per unit time for the higher concentration is always higher than for the lower concentration. The rate of loss of malathion residues ($\mu\text{g}/\text{hr}$) has been presented in Table 8.

Eventually we may conclude that the rapid dissipation of malathion from spray residues is a definite advantage when considered from the viewpoint of residues on harvested crops, but a disadvantage from the viewpoint of residual action of the toxicant for insect control.

Cook (1955) in an experimental study showed that all of the thiono and dithio phosphate pesticides tested were converted by ultraviolet and by N-bromo succinimide to anti-CHE agents that were, in general, more hydrophylic than the parent compounds.

Cook (1955) showed that, when exposed to light and air on paper, the isomers of systox are converted quite readily to two other compounds, both of which are more hydrophylic than are their parents, as judged by their action when chromatographed on paper with mineral oil and water fixed and mobile phases, respectively. Ether solutions of the parent isomers

Table 8. Rate of loss (ug/hr) of malathion residues from glass plates subjected to various wind velocities at two concentrations and for various exposure times.

Hours	Velocity : 5.65 m.p.h.		: 11.3 m.p.h.		: 16.95 m.p.h.	
	Conc. : 1000 ug:	2000 ug:	1000 ug:	2000 ug:	1000 ug:	2000 ug
1st 4 hours	39.3	43.5	48.8	61.2	91.0	98.5
2nd 4 hours	37.0	42.2	126.5	160.0	101.0	127.0
next 16 hours	26.0	51.0	5.5	28.5	5.0	22.0
next 24 hours	6.0	15.8	4.16	10.0	2.0	9.0

have been held in clear flasks in daylight for one month without any indication of change until exposure after spotting on paper. Parathion, methyl parathion, chlorthion, malathion, EPN, and diazinon were exposed to light and chromatographed in a similar manner; no new spots appeared under the conditions studied. From these results the investigator concluded that air was instrumental in the change.

In these experiments satisfactory results were obtained in determining the Rf values for technical malathion and "air degradation product(s)" of malathion, either after 24 hours or 48 hours subjected to air movement.

The Rf values of the individual compounds were identical under the experimental conditions.

It is worthy to mention that by using the described method, i.e. spot test for the determination of Rf values,

no spots could be detected in any place except the final colored zone, suggesting that the loss of the insecticide was due to either volatilization or by change to "air degradation products" which could not be detected by the above spot technique.

In the CHE inhibition, comparison of the strips treated with oxygen analogue of malathion, technical malathion, and "air degradation product(s)" of malathion, revealed that with the oxygen analogue the location of the inhibition area was established after the migration of the spot. It is of interest to note that even on using 1 ug the inhibition area was detectable.

On the other hand, technical malathion and its "air degradation products" gave a very light spot at Rf value 0.9 indicative of a weak anticholinesterase active in vitro.

SUMMARY AND CONCLUSIONS

The effect of some of the weather components, air velocity and temperature, on malathion residues on glass plates was determined.

By using a specially constructed wind tunnel, controlled air velocities and temperature were attained.

By using glass plates as exposure surface, the loss of residues of malathion was determined for exposure times of 4, 8, 24, and 48 hours, and air velocities of 5.65, 11.3 and 16.95 m.p.h., and at insecticide concentrations of 1000 and

2000 ug. The loss of the insecticide was evaluated also at room temperature ($84^{\circ}\text{F.} \pm 4^{\circ}$) and at a relatively high temperature (110°F.).

The malathion deposit was estimated chemically by the colorimetric method described by Norris et al. (1954).

There was a significant difference in the magnitude of malathion residues losses among the four exposure times for all the wind velocities. Glass plates coated with the toxicant and exposed to different wind velocities showed that there was a highly significant difference in loss of malathion residues between the extremes, 5.65 and 16.95 m.p.h., but not between 11.3 and either extreme. However the difference was not appreciable between loss at 5.65 and 11.3 m.p.h. and likewise between 11.3 and 16.95 m.p.h. But there was a significant difference in the magnitude of residue loss between 5.65 and 16.95 m.p.h.

Array of mean per cent losses of malathion residues from glass plates exposed to room conditions and protected from air currents (Table 6) shows that for both concentrations, as a whole exposed for various lengths of exposure time, there was no significant difference between 4 to 8 hours, and 8 to 24 hours. But there was a significant difference (at 0.05 level of probability) between 4 to 48 hours, 8 to 48 hours, and 24 to 48 hours.

On applying the insecticide at different rates, apparently, the lower the rate, the greater the percentage lost in a given

time. However, the total loss or the rate of loss was higher for the higher concentration and low for the lower one.

The per cent loss of malathion deposits was more extensive with the higher range of air temperature ($110^{\circ}\text{F.} \pm 1^{\circ}$).

Loss of malathion occurred more rapidly with a combination of high temperature and a 16.95 m.p.h. wind velocity; and the lesser deposit (1000 ug) resulted in a greater percentage of insecticide lost, especially in the first 4 hour period.

Using two different chromatographic techniques the compound or compounds formed due to the effect of air movement were identical with the parent compound.

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EFFECT OF SOME OF THE CLIMATIC FACTORS ON RESIDUES
OF THE PHOSPHORUS INSECTICIDE, MALATHION

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The degree of control of insects depends, to a large extent, upon residual toxicity of insecticide deposits on plant surfaces with which these insects come in contact from time to time.

It has been postulated by many workers that the high temperatures, humidities, rainfall, wind, dew, and sunlight are important factors in reducing the toxicity of several organic insecticides.

It has been reported by Metcalf and March (1956) that thionophosphate insecticides such as parathion and its methyl analogue, O,O-dimethyl O-p-nitrophenyl thionophosphate, have been shown to kill insects by inhibition of cholinesterase. Some organic phosphorus insecticides such as malathion, and parathion are weakly anticholinesterase but are converted to powerful inhibitors ("activated") by certain enzyme systems.

The tests reported herein were conducted to obtain additional information regarding the effect of environmental factors, like wind velocity and high temperature, on the amount and nature of losses of an organic phosphorus insecticide, malathion.

By using a specially constructed wind tunnel, the air velocities and temperature at various levels were obtained. By using glass plates as exposure surfaces, the loss of residues of malathion was estimated for exposure times of 4, 8, 24, and 48 hours, and air velocities of 5.65, 11.3 and 16.95 m.p.h. and at two insecticide concentrations of 1000 and 2000 ug.

The loss of the insecticide was also evaluated at room temperature ($84^{\circ}\text{F.} \pm 4^{\circ}$) and at a relative high temperature (110°F.).

The malathion deposit was estimated chemically by the colorimetric method described by Norris et al. (1954).

There was a significant difference among the four exposure times for all the wind velocities.

Glass plates coated with toxicant and exposed to different wind velocities showed that there was a highly significant difference in loss of malathion residues between the extremes 5.65 and 16.95 m.p.h., but not between 11.3 m.p.h. and either extreme. However the difference was not appreciable between loss at 5.65 and 11.3 m.p.h. and likewise between 11.3 and 16.95 m.p.h. But there was a significant difference in the magnitude of residue loss between 5.65 and 16.95 m.p.h.

Array of mean per cent losses of malathion residues from glass plates exposed to room conditions and protected from air currents show that for both concentrations, as a whole exposed for various lengths of exposure time, there was no significant difference between 4 to 8, and 8 to 24 hours. But there was a significant difference (at 0.05 level of probability) between 4 to 48 hours, 8 to 48 hours, and 24 to 48 hours.

On applying the insecticide at different rates, apparently the lower the rate, the greater the percentage lost in a given time. However, the total loss or the rate of loss was higher for the higher concentration.

The per cent loss of malathion deposits was more extensive with the higher range of hot air (110°F. $\pm 1^\circ$). Loss of malathion occurred more rapidly with a high temperature and a 16.95 m.p.h. wind velocity; and the lesser deposit (1000 ug) resulted in a greater percentage of loss, especially in the first 4 hour period.

Technical malathion and the "air degradation products" and the oxygen analogue of malathion were examined by paper chromatographic technique similar to that previously described by March et al. (1954), Kaplanis (1954), Ware (1955) and Cook (1955).

Upon using the two different chromatographic techniques the compound or compounds formed due to the effect of air movement were identical with the parent compound.