INSECTICIDE TRIALS AGAINST THE POTATO TUBER MOTH, GNORIMOSCHEMA OPERCULELLA ZELL. (Gelech. Lepidoptera)

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Abstract

A number of insecticides including chlorinated hydrocarbons, organophosphates and carbamates were tested against the larvae and adults of the potato tuber moth, Gnorimoschema operculella Zell, in Israel.

Introduction

Potato growing in Israel has increased in recent years through its introduction into new areas and expansion of existing areas of cultivation. The potato tuber moth, Gnorimoschema operculella Zell., though known to be present in the country, was not known to cause damage to potatoes in the 1920's, In the 1940's it was still considered only as a storage pest. In recent years the potato tuber moth has become a major pest in the field, injuring both foliage and tubers before picking. Damage is especially heavy in loess soils which tend to crack and *expose* the tubers.

In spite of the control measures used in recent years, extensive damage has occurred. It was suspected that the pest had become resistant to conventional insecticides, especially D. D.T,, as was surmized elsewhere(6), In 1963, a number of insecticides were evaluated on G. operculella larvae and moths.

Contribution from The National and University Institute of Agriculture, Rehovot, Israel, 1964, Series, No. 730-E.

Materials and Methods

Insecticides

The following insecticides were tested:

Chlorinated hydrocarbons: D. D. T. 25% E. C.; Endrin 19.5% E. C.; Lindane, 20% E. C., Thiodan, 35% E. C. and Toxaphene, 80% E. C. at rates (concentrations) of 0.2% and 0.4% active ingredient.

Organophosphates: Cotnion, 20% E. C. (a local brand of Guthion), Diazinon 25%, E. C., Dipterex, 80% W. P. and Phosphamidon, 50% solution at 0.2% active ingredient.

Carbamates; Sevin, 50% W. P.; Zectran 22, 3% E. C. at 0.2% active ingredient.

Biological tests

A. Moths

The effects of insecticides on the moths were tested by various methods.

1. Forced contact of moths with treated glass plates.

Glass plates were dipped in various formulations (emulsions and suspensions) of the insecticides tested. After two hours, the moths were brought into forced contact with the residues. After 30 minutes' contact, the moths were removed for observation into clean containers and fed on a sugar solution. Mortality was recorded 3, 24 and 48 hours after removal from the treated surfaces.

2. Forced contact of moths with treated leaves.

Eggplant leaves in the field were dipped in various formulations of the insecticides. One hour after treatment, moths were brought into forced contact with treated leaf samples in test tubes 22 mm. in diameter (the inner surface being lined with treated leaves). After contact the moths were kept for observation. as in method 1.

3. Weathering of insecticidal layers in the field.

The insecticides which were effective when tested on the leaves were studied further as to their persistence in the field. This was carried out as experimental layout 2, but the leaf samples for the forced contact were taken 1, 3 and 5 days after treatment.

Each insecticide was tested on 50 moths, in five groups of 10. Per cent kill was corrected for control mortality according to Abbott (1).

B. Larvae

The effect of insecticides on larvae by contact and through the stomach was tested by various methods: insecticides applied to leaf surfaces; soil insecticide treatment; or tuber treatment.

1. Insecticides applied to leaves.

a) Eggplant leaves were dipped in formulations of the insecticides tested. After one hour larvae were brought into forced contact with the leaves for 60 minutes, in glass jars 50 mm. in diameter, lined with the treated leaves. During the forced contact the larvae also fed on the treated leaves. After the contact the larvae were removed into clean containers and were allowed to feed on untreated leaves. Mortality was recorded after 3, 24 and 48 hours.

b) The residual effect of the insecticides after weathering outdoors was assessed by treated leaf samples, which were used for forced contact 1, 3 and 5 days after treatment.

c) A further assessment of the insecticides was made by allowing larvae to penetrate into eggplant leaves, after which the leaves were sprayed on both sides with the insecticides tested. Mortality was recorded 24 and 48 hours after treatment.

The tests of larvae on the leaves were carried out in three replicates, 10 larvae for each replicate. Per cent kill was corrected according to Abbott(1).

2. Soil treatment.

a) After irrigation. Potato tubers were placed in round plastic containers and were covered with a 2-cm layer of soil which was irrigated with a uniform amount of water. After 24 hours the soil was dusted with 0.2 gram active ingredient of either D.D.T., Sevin, Thiodan or 0.12 gram Diazinon per square meter and infested with larvae. Each insecticide was tested on 60 larvae in groups of 10. The efficiency of the various treatments was calculated according to the number of live larvae recovered within the tubers.

b) Before irrigation. The procedure of this test was as in a.), except that the soil was dusted with the insecticide before irrigation.

3. Tuber treatment.

Potato tubers placed on a thin layer of sand were dusted with 0.2 gram active ingredient either of D.D.T., Sevin or Thiodan, or 0.12 gram of Diazinon per square meter, after which larvae were placed on them. Mortality was recorded after 48 hours. Each insecticide was tested on 30 larvae in three replicates.

Results.

The efficiency of the insecticides against moths.

The results obtained by forced contact of moths with insecticides on glass and leaf surfaces one hour after application are presented in Figure 1. Of the chlorinated hydrocarbons tested, Lindane caused high mortality both on glass and leaf surfaces. The other hydrocarbons caused low mortality on glass plates but their efficiency increased when applied to the leaves; Toxaphene was the exception, it was ineffective also on the leaves. of the organophosphates, Diazinon was the most effective, followed by Cotnion and Phos-

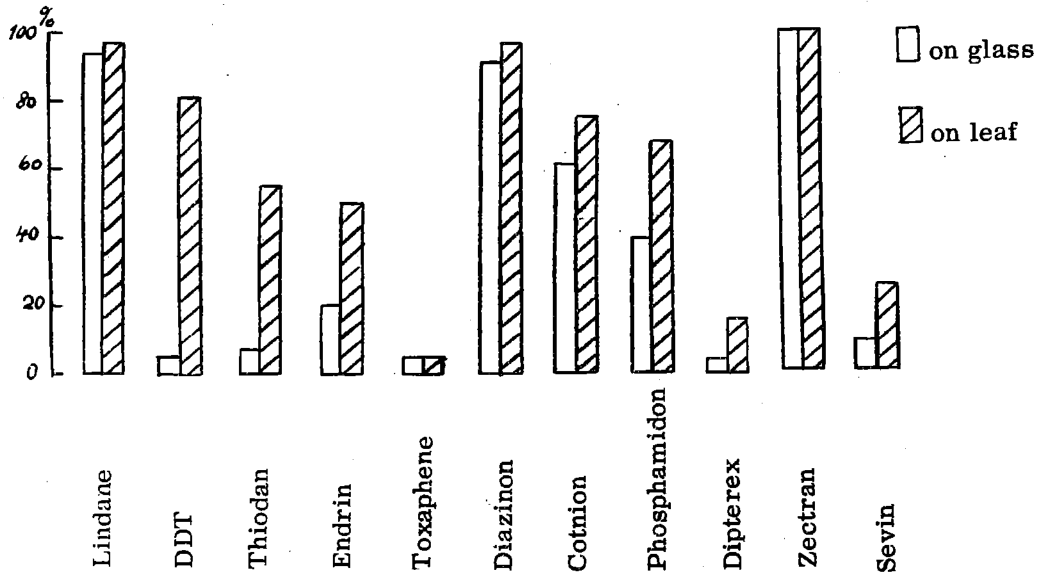


Fig. 1 Percent kill of G. operculella moths, 48 hours after 30 minutes' forced contact with glass or leaf surfaces dipped in insecticides.

phamidon, while Dipterex was ineffective on both surfaces. Of the carbamates, Zectran caused complete mortality on glass and on leaves, Sevin exhibited

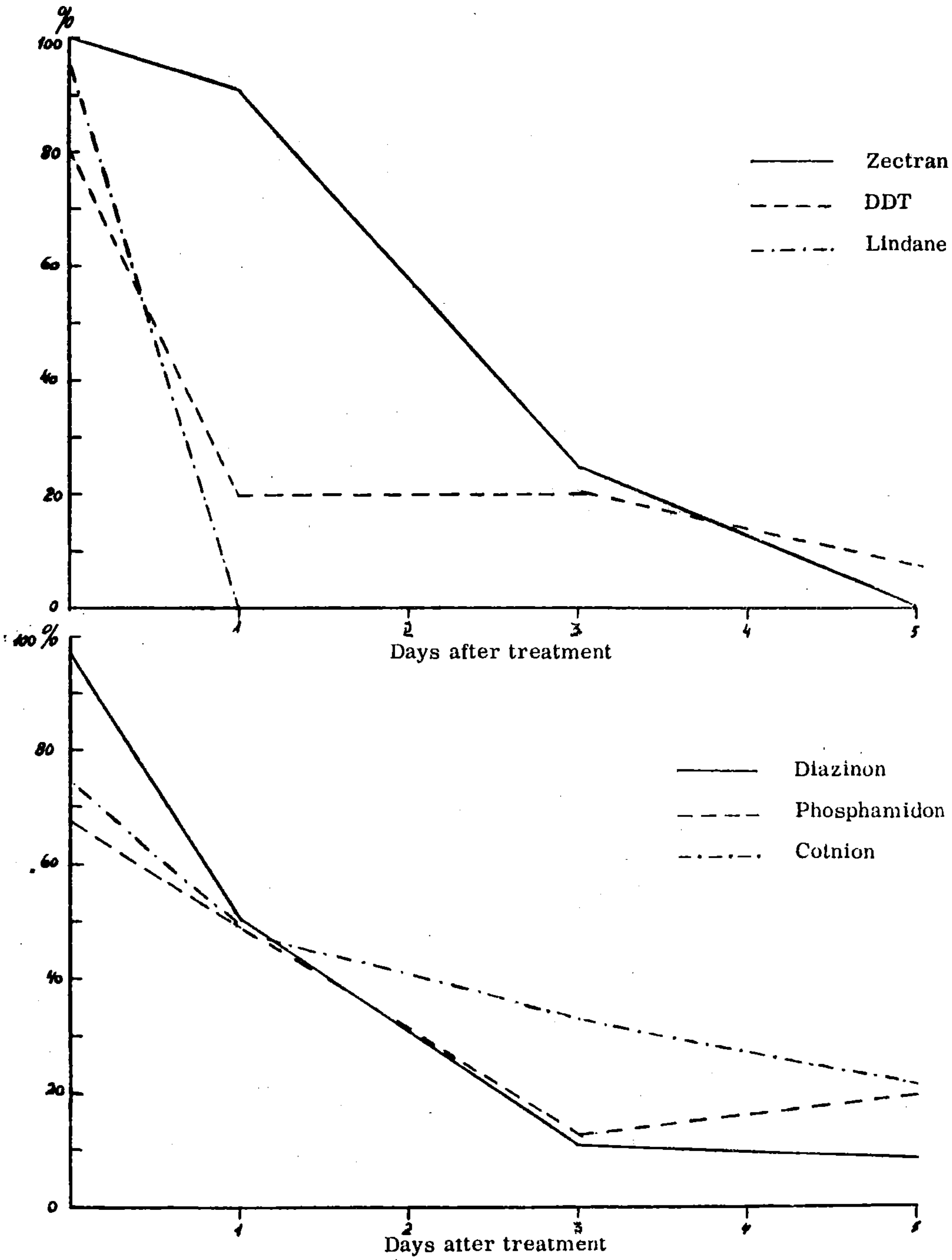


Fig. 2. Percent kill of G. operculella moths, 48 hours after 30 minutes' forced contact with leaves dipped in insecticides and weathered outdoors.

low activity on glass and better on leaves; Zectran was the most effective insecticide while it remained active, but it became ineffective on the fifth day.

The results of moth mortality obtained after weathering of insecticides are shown in Fig. 2. Of the chlorinated hydrocarbons, the effectiveness of Lindane dropped sharply and so did that of D. D. T. (Fig. 2a). Of the organophosphates, Diazinon, Cotnion and Phosphamidon were equally toxic after 24 hours' weathering, but after 3 and 5 days, Cotnion surpassed the others in activity.

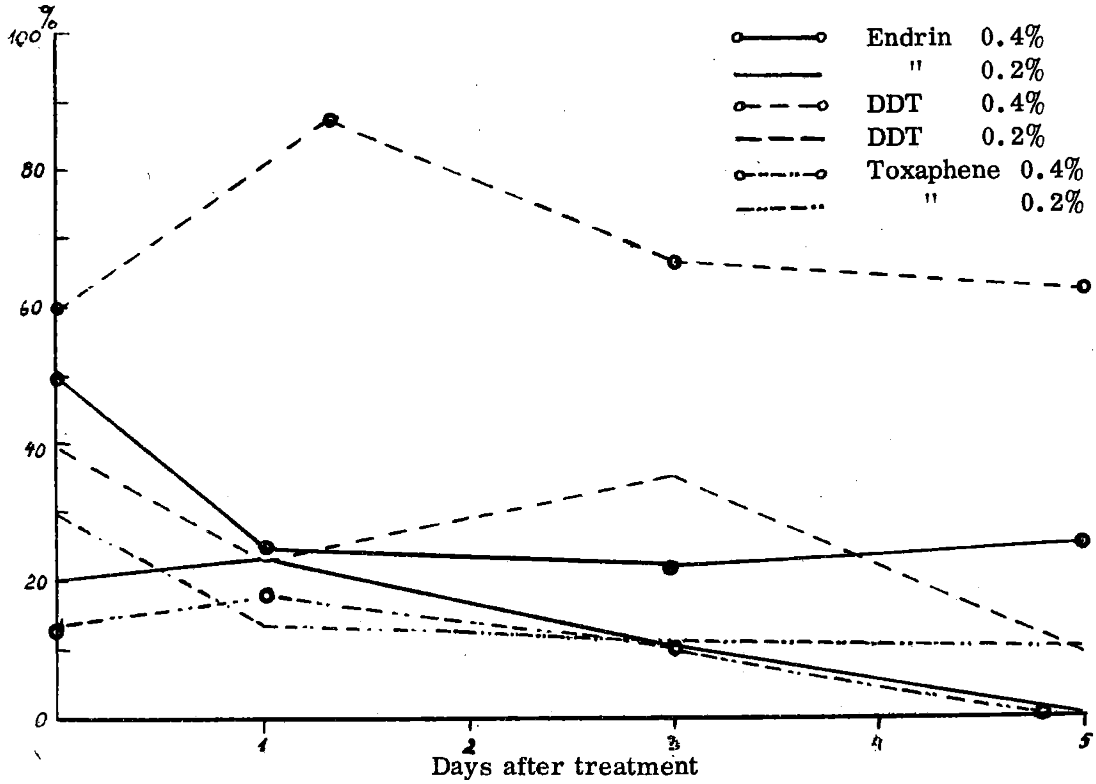
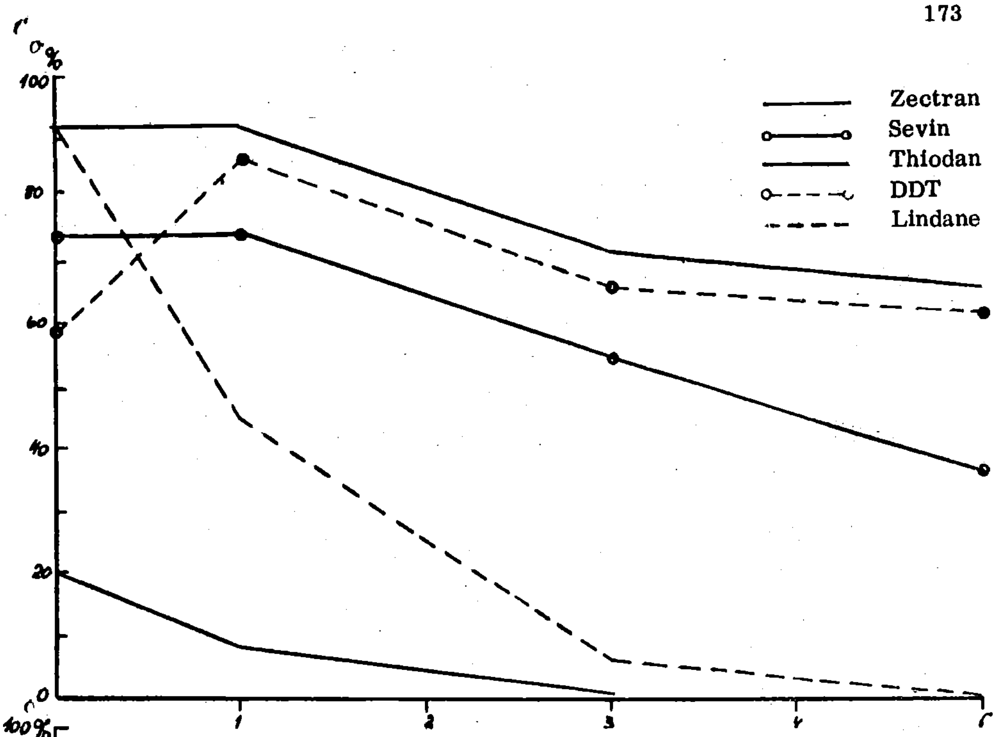


Fig. 3. Percent kill of G. operculella larvae, 48 hours after 60 minutes' forced contact with leaves dipped in two concentrations of chlorinated hydrocarbons and weathered outdoors.

The efficiency of insecticides against larvae.

1. a) mortality of larvae caused by two concentrations of D. D. T., Endrin, and Toxaphene after weathering outdoors is shown in Fig. 3. Only



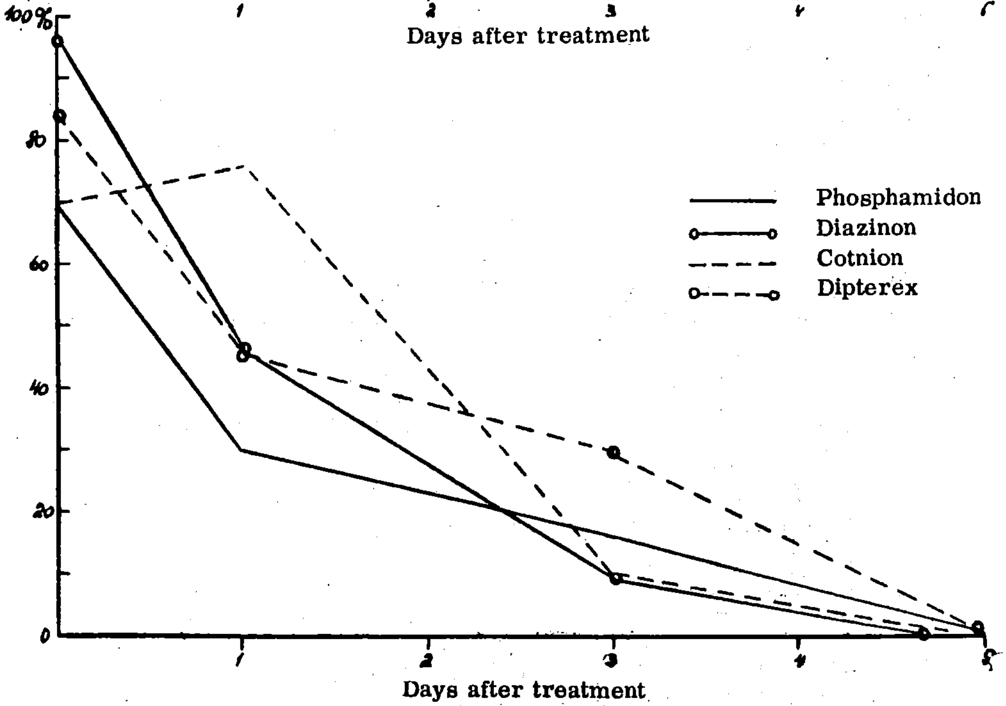


Fig. 4. Percent kill of G. operculella larvae, 48 hours after 60 minutes' forced contact with leaves dipped in insecticides and weathered outdoors.

the higher concentration of D. D. T. caused satisfactory mortality throughout the test period.

The per cent kill of larvae 48 hours after forced contact with insecticide residues outdoors is presented in Fig. 4.

All the organophosphates were effective on the first day, but only Cotnion remained partially effective for the following two days (Fig. 4b). Of the carbamates and chlorinated hydrocarbons, Zectran and Sevin were effective throughout the test period, while D. D. T. at the higher concentration

Table 1.

Per cent kill of G. operculella larvae present in eggplant leaf tissue after spraying both sides of the leaf.

Insecticide and concentration of active ingredient	% dead and knocked down larvae after	
	24 hours	48 hours
D. D. T. 0.4%	81	100
Diazinon 0.1%	100	100
Dipterex 0.1%	10	25
Cotnion 0.1%	100	100
Phosphamidon 0.1%	85	100
Zectran 0.2%	100	100
Sevin 0.2%	83	100

Table 2.

Percent survival and kill of G. operculella larvae 48 hours after inoculation of the soil in which treated tubers were placed.

Insecticide and conc. a. i.	% larvae	
	live	dead
Control	77	10
Thiodan 4%	50	27
Diazinon 2.5%	20	43
D. D. T. 10%	33	50
Sevin 10%	17	63

approached Zectran in efficiency. Thiodan was not efficienct, and Lindane, which was quite active on the first day, deteriorated on the following day, yielding only 5% mortality.

1. b) Mortality caused by insecticides to larvae present in the leaf tissue at the time of application is given in Table 1. Most insecticides tested were quite active, except for Dipterex, which was ineffective, but the rate of their activity varied.

2. The survival rate of larvae which passed through a layer of soil treated with various insecticides is given in Fig. 5. The assessment was made by counting the number of larvae which penetrated the tubers after having passed a layer of treated soil. The per cent of live larvae was higher when the soil was treated before irrigation, with post-irrigation treatment yielding better control. In these experiments, D. D. T. and Sevin were more efficient and caused a higher mortality than Thiodan and Diazinon. In the pre-irrigation treatment there was no difference between the various insecticides tested, all of which reduced the number of live larvae to some extent.

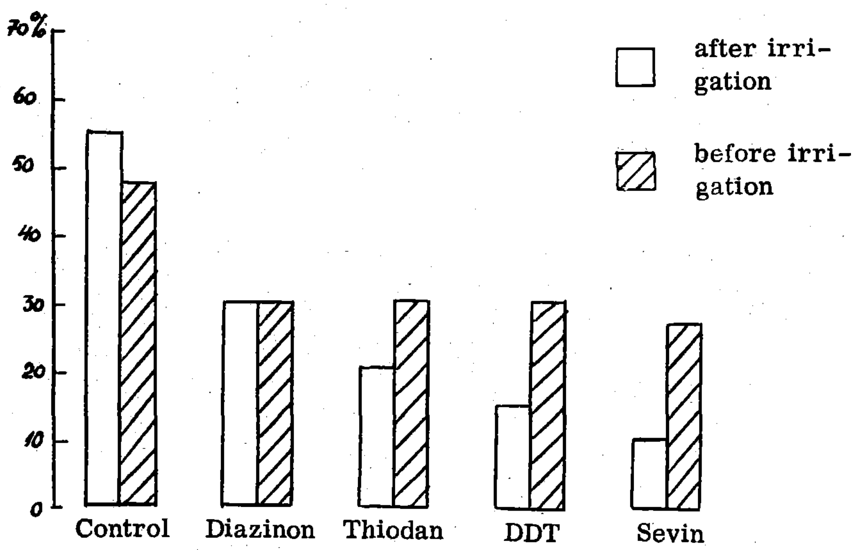


Fig. 5. Percent survival of G. operculella larvae after passing through a treated layer of soil.

3. The per cent kill of larvae obtained by dusting the tubers is presented in Table 2. The order of effectiveness was Sevin, D. D. T., Diazinon and Thiodan.

Discussion

From the tests against moths and larvae of G. operculella, it is evident that efficiency of the insecticides against these stages was not equal. As a rule the larvae were more susceptible than the moths, and the effects of residues were longer lasting on the larvae.

The difference in the action of insecticides when applied on glass or leaf surfaces is quite interesting. The chlorinated hydrocarbons, except Lindane and Toxaphene, were more effective when applied to leaves than to glass. The residues of Lindane on both surfaces were highly effective, which is probably due to its high vapor pressure. Toxaphene was inactive on both surfaces. The higher activity on leaves was outstanding mostly with D. D. T. (causing 80% kill on leaves and only 5% on glass, at 0.4% active ingredient). This is in full accord with results obtained by Ward and Burt (5, 7) who compared residues of D. D. T. on sisal and cabbage leaves to residues on glass surfaces. They found that the residues on leaves were four times more active than those on glass. They tried to explain this by the higher relative humidity produced by the leaves, which increases the action of D. D. T. It is also quite possible that the D. D. T. dissolves in the wax layer covering the leaves, and dissolved D. D. T. is more active than the crystalline form (2, 3).

Similar differences between residues on leaf and glass were also observed with the organophosphates. Of the carbamates, Zectran was so highly active that no difference could be observed, while Sevin produced analogous differences.

In the tests carried out with larvae within the leaf tissue, the same order of effectiveness was found as with one-hour fresh residues on the leaves. In both cases the effective insecticides were Zectran, Cotnion, Diazinon, Sevin and Phosphamidon. Cotnion yielded the same results in the field, causing complete mortality of larvae present in the foliage (8). Similar tissue penetration was observed in California, when Guthion was applied for control of the tuber moth larvae in the leaves (4).

D. D. T. and the carbamates were the most persistent compounds against the larvae after various weathering periods. Of the organophosphates, Cotnion was slightly more persistent than Diazinon, perhaps because of the high vapor pressure of Diazinon.

Summary.

Toxicological studies on the adults and larvae of the potato tuber moth, Gnorimoschema operculella Zell., were carried out with various insecticides. Of the chlorinated hydrocarbons, Lindane was highly effective on the first day, but dropped to complete inactivity on the next. D. D. T. was effective against the moth, especially on the first day, and at 0.4% a.i. gave a long residual effect against the larvae; good control of larvae was also obtained by dusting the tubers or soil. Endrin and Toxaphene were ineffective against

both stages on the first day, but Cotnion surpassed it in residual effects against both stages. Dipterex was ineffective against the moths, but its residues gave fair kill of larvae, while Phosphamidon gave good control of both stages. Of the carbamates, Zectran was the most effective of all insecticides tested against both stages. Sevin was ineffective against the moths, but was quite effective on the larvae; it gave good protection of tubers by dust applied to the tuber or the soil.

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