where heavy dosage was used. *o*-Dichlorobenzene is also extremely repellent, but its activity duration is very short even if it is applied in relatively high concentration. At the same time it has fumigant effect, and about 50% of knockdown or moribundity occurred following the exposure of flies for test periods of 60 minutes.

DDT and dieldrin are significantly attractive to flies. When the flies perceived the odor, they follow the direction of source of the odor. γ-BHC is also somewhat attractive, though not so significant. Results for sulfoxide, allethrin and pyrethrins were not significant. Crag fly repellent is somewhat more repellent than the others.

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On the Repellent Efficiency of Certain Insecticides and Their Mode of Action to Adult Housefly. Insect Repellents and Attractants. V. Yasunosuke IKEDA (Takamine Laboratory, Sankyo Co., Ltd, Yasu-cho, Shiga Pref.). Received May 27, 1958. *Botyu-Kagaku* **23**, 102, 1958.

19. 家蠅に対する殺虫剤の忌避効力とその作用様式について　忌避剤・誘引剤について　第5報*

池田安之助（三共株式会社　高峰研究所）. 33. 5. 27 受理

イエバエ成虫に対する味覚，触覚，および嗅覚忌避試験ならびにこれと併行した殺虫試験の結果から，ピレトリンやアレスリンのイエバエに対する忌避作用は主として味覚（または触覚）によるもので，嗅覚忌避でないことを明らかにした．また他の殺虫剤についても同様の傾向が認められたが，その効力は顕著でなかった．

Although extensive effort has been expended to find the repellent or attractive properties of certain residual insecticides against various species of insects under laboratory conditions or in field tests, there still remained something of uncertainty in their actual mode or the physiological mechanism of repellency.

In the previous papers[4—7], the author reported on the repellency of certain insecticides to adult housefly. The term repellency was used in previous tests to refer to any complex of stimuli, gustatory, tactile or olfactory, which results in a laboratory method by using the lactose pellet.

In this paper, the author has dealt with the olfactometric tests of certain volatile insecticides to adult houseflies to find out any correlation between repellent and insecticidal efficiencies of insecticides, and also to try to answer the question,

* 本報告の概要は昭和33年3月30日～4月1日の日本応用動物昆虫学会大会（於東京大学）において発表した．

how pyrethrins causes the flies to keep away from a place which has been treated with it.

The author wishes to express his appreciation to Dr. O. Shinoda, Prof. in Osaka University of Liberal Arts for his kind guidance and encouragement given him during the course of the present work. The author is also deeply indebted to the director N. Kumasawa of this laboratory and Mr. Y. Hamada, the chief of chemical laboratory of this company for their helps.

Materials and Method

The materials adopted for the experiments are pyrethrum extract containing 17.4% of pyrethrins, commercial allethrin of 97.7% purity, technical pure chlordane, and Tabutrex, di-*n*-butyl succinate, one of the repellents that has been widely investigated. Test formulations are made by dissolving each material in acetone.

Olfactometric Tests

The insect used was the adults of the common housefly, *Musca domestica vicina* Macq., which have been bred in the laboratory. In the case of the test, 20 female flies of 2 to 3 days old were used for each test.

The olfactometer employed was the T-tube type according to the principle of McIndoo's Y-tube[5]:

A glass tube 3.4cm in diameter and 48cm long with an air outlet vertically upward and an insect entrance attached at the center of the saturation chamber consisted of glass bottle of 500cc capacity. The bottle was closed with a cork stopper, and was connected to both ends of the T-tube by a short glass tubing.

The parallel streams of air are passed through a set of two 500cc bottles, one of which is empty while the other contains an insecticide to be tested.

The air flow in the T-tube averages 1,800 cc per hour. The test is carried out at the room temperature. The air is passed through a saturated NaCl solution, so as to keep the humidity relatively constant.

A folded filter paper of 7.5×12 cm (90 cm^2) is soaked with 1cc of an acetone solution of a given amount of the test insecticide. The impregnated paper is exposed in air to let certain solvent evaporate up, and is placed in the saturation bottle. Air flows for ten minutes before flies are introduced into the test chamber. They are drawn into the chamber by an electric lamp from opposite side of the chamber out of the container, after which tests are carried on in a dark, the T-tube being examined under dim light at intervals 30 minutes.

The repellency or attraction was based on the numbers of flies which entered in either the odorless (check) arm or the odorous (test) arm. Where an appreciable greater number of flies entered the odorless arm indicated repellence to the odor, while in time of a greater number of flies came into the odorous arm, attraction was indicated. Where an equal number of flies entered or remained in either arm of the T-tube, a neutral reaction was indicated. The results of olfactometric tests are given in Table 1.

Results : Allethrin and Pyrethrins. No significant evidence of repellency or attraction was observed for these materials. The flies responded to the odor of pyrethrins very little even in higher concentrations. Moreover, the reactions are rather attractive, not repellent.

The repellency of chlordane was highly significant where heavy dosage such as the ratio of 2 g per ft^2 was used, but in the usual dosage it appeared neutral in effect.

Tabutrex. The results of olfactometric tests for Tabutrex were not significant, though the flies were a little excited when they inhaled heavy doses of Tabutrex.

The Relation between the Repellent and the Insecticidal Properties of Certain Insecticide Residues

In order to ascertain the relation between the repellent and insecticidal properties of certain insecticide residues, the following experiments were performed preliminarily.

Insecticidal tests : The insect used was the adults of azuki bean weevil, *Callosobruchus chinensis* L., which had been reared on azuki bean for several years in this laboratory.

Table 1. Reaction of the female houseflies, *Musca domestica vicina* Macq., to the odors of certain insecticides in an olfactometer. At 21—24°, relative humidity 72—80%. Results of five replicates.

Material	Dosage mg per ft²	Reaction percent					
		Tendency*			After 60 min.		
		Attraction	Neutrality	Repellence	Attraction	Neutrality	Repellence
Allethrin	2000	60.0	—	—	72.0	—	—
	1000	—	50.0	—	90.0	—	—
	500	—	50.0	—	74.0	—	—
	250	—	moved	—	—	50.0	—
Pyrethrins	1000	—	50.0	—	62.0	—	—
	500	—	50.0	—	60.0	—	—
	250	60.0	—	—	—	50.0	—
Chlordane	2000	—	—	85.0	—	—	57.0
	1000	—	50.0	—	—	50.0	—
	500	—	50.0	—	—	50.0	—
	250	—	50.0	—	60.0	—	—
Tabutrex	2000	—	—	85.0	—	—	85.0
	1000	—	—	60.0	—	—	60.0
	500	—	50.0	—	—	50.0	—
	250	—	moved	—	64.0	—	—

* Reaction at first instant of flies were drawing into the test chamber where circulation of the air was in operation.

In the case of the test, 25 adults of 1-day-old were used for each test.

The reason why azuki bean weevil was adopted for the insecticidal tests is that this species has been widely utilized as test insect for determining the contact poisoning effect because it takes no foodstuff after emergence.

The method employed for keeping the insects in contact with the surface residues was the conventional ones. Round pieces of filter paper, 9 cm in diameter, are soaked with 0.7 cc acetone solutions of desired concentration, and as soon as the main part of the solvent has evaporated off, the treated papers are placed in petri dishes of 9 cm in diameter.

The insects are enclosed in these petri dishes, and are kept at 28° for 48 hours. Mortality counts are taken at 24 and 48 hours after exposure.

Table 2. Mortality percent of the weevils, *Callosobruchus chinensis* L., exposed to the different residues of certain insecticides on filter paper. Exposure for 48 hours at 28°. Average of five replicates.

Material / Dosage mg/ft²	Mortality percent			
	Pyrethrins	Allethrin	Tabutrex	Chlordane
500.00	—	—	8.0	100.0
250.00	—	—	4.0	100.0
100.00	—	—	0.0	99.0
50.00	—	—	0.0	93.0
25.00	—	—	0.0	91.0
10.00	50.0	94.0	0.0	86.0
5.00	10.0	11.0	0.0	78.0
2.50	4.0	4.0	—	—
1.25	0.0	2.0	—	—
0.62	0.0	0.0	—	—
0.31	0.0	0.0	—	—

The results of the tests are given in Table 2. The results together with the results of the repellent tests obtained in houseflies, in order to compare the repellency and insecticidal efficiencies, are given in Fig. 1.

Repellent Tests with Lactose Pellets : Tests are made on the adults of the common housefly, *Musca domestica vicina* Macq., bred in the laboratory. The criterion of repellency was based on the amount of feeding on lactose pellet put on papers soaked with given amounts of the chemicals. These experimental details were essentially similar to the previous tests[4—6].

The results of the tests are given in Table 3 and Fig. 1.

Table 3. Comparisons of repellent efficiency of certain insecticide residues to the adult houseflies, *Musca domestica vicina* Macq., in laboratory tests. Exposure for 20 hours at 28—32°. Average of five replicates.

Material / Dosage mg/ft²	Repellency percent ± P. E. s. *			
	Pyrethrins	Allethrin	Tabutrex	Chlordane
500.00	—	—	98.7± 1.3	—
250.00	—	—	86.3± 5.0	40.7±14.6
100.00	—	—	57.9± 9.0	37.5±15.4
50.00	—	—	51.2±11.9	38.2±14.7
25.00	—	—	52.5±12.7	31.8±16.2
10.00	94.2± 6.9	95.2± 4.4	8.3± 5.3	19.0±12.6
5.00	73.6± 8.7	79.2± 8.8	—	5.1± 5.0
2.50	59.1±10.9	60.1±10.1	—	—
1.25	51.2±12.5	54.3±10.9	—	—
0.62	37.2±19.2	48.9±11.6	—	—
0.31	1.7± 2.5	0.9± 1.3	—	—

* P. E. s. : 0.6745σ.

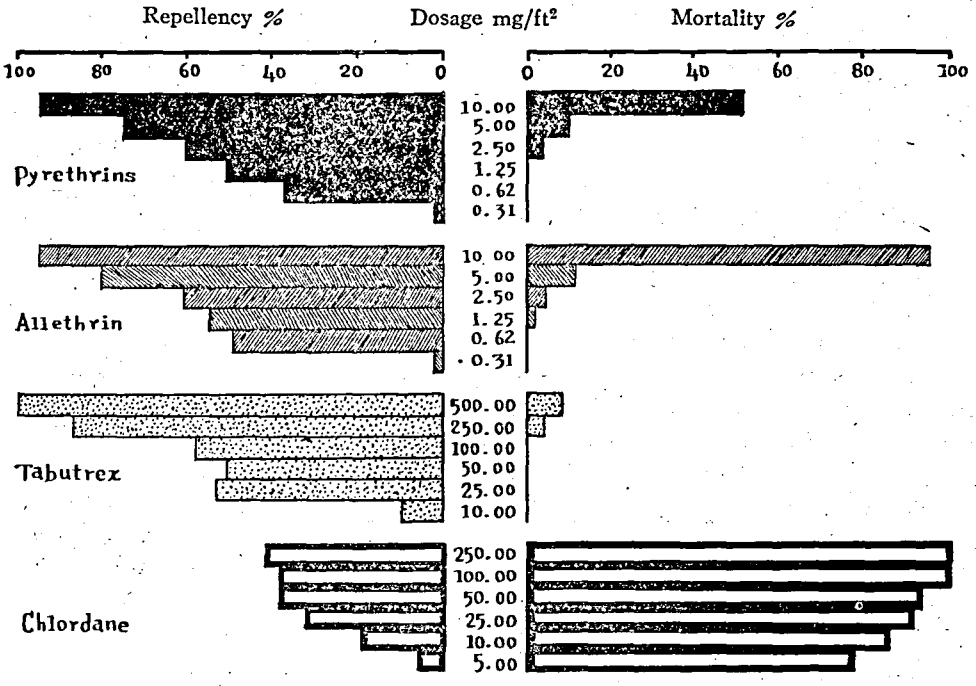

Fig. 1. Relation between the repellency and insecticidal efficiency of certain commercial repellent and insecticide residues.

Correlation between the Repellency and Insecticidal Efficiency

The results of insecticidal toxicity of certain repellents and insecticides to azuki bean weevils and the repellent capacities of the same to houseflies are given in Fig. 1.

Chlordane is practically non-repellent when an usual dosage, 250 mg/ft^2, is used.

If very heavy deposits (2 g/ft^2) is used, flies are paralyzed before they can eat the lactose pellet put on the treated paper.

It is needless to say that Tabutrex is a repellent and is not intended to kill or destroy insects. In these tests, however, its repellent activity decreased with the degradation of the surface deposits.

Pyrethrins and allethrin act repellently. Flies fly away at the moment on the soaked materials. It is generally considered that the active principles of the pyrethrum flowers are two esters and two acids, in addition to cinerolone revealed by Laforge and Barthel[8]. Since the pyrethrins and cinerins are esters, they are rather easily decomposed, and become inactive as insecticide, particularly in the presence of air and moisture.

However, the tests have shown that the pyrethrins and allethrin keep high repellency independently of the decrease in their insecticidal activity.

Discussion

Practically, under laboratory tests, certain commonly used insecticides including chlorinated hydrocarbons, phosphates, and plant products give good initial kill and residual control against insects as far as the insect are confined in an reaction chamber, while in outdoor operation, the control efficiencies of these insecticides are often relatively poor. The difference between laboratory and field experiments may depend on a number of factors.

One of them, it is sometimes observed that certain insecticides act as repellent, so that insects fly away into free air before they take up lethal doses.

Most of chlorinated hydrocarbon insecticides are practically non-repellent where the usual dosages are used. If they have some repellency, their effectiveness and the degree of repellency may be bound up with concentration.

Pyrethrins and allethrin are repellent to houseflies. The repellency may be caused by gustatory or tactile sense organ of the flies. Pyrethrins and allethrin do not promise to be vapor phase repellency.

Résumé

In this paper, the author dealt with the olfactometric tests of certain volatile insecticides to the adult houseflies, and some quantitative information on the correlation between the repellency and insecticidal efficiency of some insecticide residues against adult houseflies and azuki bean weevils under laboratory conditions.

From the results so far obtained, the author disclosed the mode of repellent action of some insecticide residues upon the adult houseflies.

Chlorinated hydrocarbon insecticide such as chlordane was practically non-repellent to flies. Natural plant products such as pyrethrins and allethrin were repellent. These materials gave high repellency independently of the degradation of their insecticidal activity.

In so far as the mode of repellent action of pyrethrins and allethrin on houseflies are concerned, it may be concluded that pyrethrins and allethrin do not promise to be vapor phase repellents. Their activity may be attributed to the contact, gustatory repellencies or complex of them.

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Testing Laboratory Methods of Agricultural Chemicals against Injurious Insects in Soil. Researches on the Wireworm, *Melanotus caudex* Lewis. XI. Masayoshi YOSHIDA & Yasunori SUZUKI (Laboratory of Applied Entomology, Faculty of Agriculture, Shizuoka University, Iwata, Shizuoka, Japan). Received June 30, 1958. *Botyu-Kagaku* **23**, 107, 1958.

20. 土壌害虫に対する農薬の室内試験法. ハリガネムシに関する研究 第11報 吉田正義・鈴木康徳（静岡大学農学部 応用昆虫学研究室）33. 6. 30 受理

木材粉を利用したハリガネムシの飼育装置に一定量の乳剤，ガス剤および粉剤を含有せしめ，相当長期間に亘る農薬の累積的殺虫効果を調べる土壌害虫に対する農薬の室内試験法を考案したのでこれを紹介すると共に若干農薬の特性について報告した.

Introduction

Testings of insecticide against soil insects have been carried out with the end result of yield of crops, when applying or not applying. In this case, the result may be caused by two mingling factors, repellency and toxicity of the applied chemical. For the yield of crop differs in every year due to climatic factors, kind of soils and biological factors and so on, it is difficult to estimate the effectiveness of insecticide by this method. Since the large-scale field test has some faults as mentioned above, the small-scale testing method in a laboratory is urgently needed under same conditions as in soil.

Dusting and dipping methods are now generally used to test insecticides, but in the case of soil insects these method cannot be used, for the residual toxicity must be taken into consideration in great deal. The method is bound to put given quantity of insecticide into the soil where the insects live. But there are several difficulties in this method as following: the insects cannot live in the soil transferred to the laboratory due to the decrease of water content of soil and the changes of the microorganisms in soil.

In upland farm soil, moisture content is comparatively constant since its water maintenance is kept by capillarity, and this condition lets soil insects live in optimum life. Accordingly, to maintain water content of soil in the laboratory, water must be showered. But by this showering the soil turns solid and worms cannot survive. On the other hand, the low abilities of water maintenance of soil hinder to contain certain concentrations of insecticides. When the authors bred wireworms in the soil taken into the laboratory, microorganisms increased suddenly; its degree of increase was high when moisture contents of soil was high. Enormous multiplication of microorganisms in soil brings the worm to death; soil sterilization is necessary to test the agricultural chemicals in the soil. By this sterilizing procedure humus contained in soil burns and its water maintenance becomes difficult. To solve these difficulties mentioned above, the authors used sawdust as a substitute of soil, of which water-holding capacity is large and which is easily sterilized in autoclave. As for soil insecticides, in particular, the stability of their chemical composition and the residual effectiveness are important. By the usual methods mentioned above it is difficult to appraise exactly effectiveness of the chemicals as soil insecticide. To find out effective soil insecticides, the authors applied dusts, emulsions and gas agents now on the market for the method concerned.

Materials and Methods

The test insects, larvae of *Melanotus caudex* Lewis (size : 1.5—2.0 cm), were collected at the experiment farm (Shinbara & Iwata, Shizuoka Pref.) in June and October 1957, in which seasons the worm is living near the soil surface.