Effects of Permethrin, Fenitrothion and Lindane on Oviposition of *Lyctus brunneus* STEPHENS (Coleoptera : Lyctidae)

Takaaki ITO and Chuji HIROSE

*Research Department, Pesticides Division, Sumitomo Chemical Co. Ltd., 4-2-1
Takatsukasa, Takarazuka, Hyogo, 665 Japan*

(Received December 10, 1980)

The adults of *L. brunneus* were liberated into a petri dish, in which treated wood alone (single arrangement), or together with untreated wood (twin arrangement) was placed. In single arrangement, no or few ovipositions were observed in the wood treated with permethrin at concentrations which were not lethal to the adults. In twin arrangement, the adults laid eggs in the untreated wood, but not in the treated wood even at the lowest concentration (2.0 ppm). Evidently, the adults avoided the wood treated with permethrin for oviposition. Ovipositions occurred on wood treated with lindane as well as on untreated wood in the same petri dish, though the total number of eggs laid decreased with the concentration of lindane. In the case of fenitrothion, the number of eggs was larger in the untreated wood than in the treated wood. For example, no egg and 24 eggs were laid in the treated and untreated wood, respectively, at the highest concentration (2000 ppm). There was a large difference in the effects on oviposition of the three insecticides.

INTRODUCTION

ITO and HIROSE (1980a) observed that synthetic pyrethroidal insecticides, fenvalerate, fenpropathrin and permethrin, protected wood from attack by *Lyctus brunneus* at concentrations lower than those which showed lethal toxicity to the adults. They suggested that the pyrethroids inhibited oviposition without killing the adults, because no egg was found in the wood treated with the pyrethroids.

In this paper, the inhibitory effect of permethrin on oviposition was confirmed by using the 'veneer technique' (ITO and HIROSE, 1979). The effects of fenitrothion and lindane were also studied in comparison with permethrin.

MATERIALS AND METHODS

Lyctus brunneus successively reared on an artificial diet (ITO and HIROSE, 1980b) was used throughout this work. Insecticides used were fenitrothion [0,0-dimethyl 0-(3-methyl-4-nitrophenol) phosphorothioate, 95.6%], permethrin [3-phenoxybenzyl 2,2-dimethyl 3-(2,2-dichlorovinyl)cyclopropane-1-carboxylate, 92.4%] and lindane [1,2,3,4,5,6-hexachlorocyclohexane, 99.8%]. Wood-veneers were prepared as previously described (ITO and HIROSE, 1978). The sapwood of the tropical wood, Jeultong, containing over 3.0% starch was selected and shaved to 0.2 mm thicknesses.

The shavings were immersed in water. Three overlapping pieces were piled, cut to 1.5-cm lengths, 1.5 cm in width, pressed between two glass plates and then dried at 90°C for 24 hr. The resulting veneer was dipped in an acetone solution of an insecticide at a given concentration for 2 sec. After drying at 25°C for 24 hr, one of the treated veneers was placed alone ('single arrangement'), or together with a veneer-treated with acetone only ('twin arrangement') in a petri dish. A filter paper was placed under the veneers as a foothold for the adults. Five pairs of female and male adults were liberated into the petri dish. The dish was covered with a lid. Mortality was observed 24 hr after liberation. Moribund and collapsed adults were considered as dead individuals. Eggs laid in each veneer were counted after removing the adults. Experiments were repeated four times.

The effect of lindane vapor on the mortality of the adults was evaluated. One of the veneers treated with lindane as mentioned above was placed in a petri dish, or attached to the lower surface of the lid. Five pairs of female and male adults were liberated into each dish. Mortality was observed after 24 hr. Experiments were repeated. Moreover, the effect of lindane on oviposition was reexamined at concentrations which were not lethal to the adults. The experiments were done according to the 'twin arrangement' as mentioned above and repeated 7 times.

RESULTS

Five pairs of adults were liberated into a petri dish, in which the treated veneer alone, or together with an untreated one was placed. Tables 1, 2 and 3 show the results for fenitrothion, permethrin and lindane, respectively. In the case of fenitrothion, the mortality of the adults was evidently lower in the twin arrangement than in the single arrangement. A coefficient of correlation between the mortality rate

Table 1. EFFECT OF FENITROTHION ON OVIPOSITION OF *L. brunneus*

Arrangement	ppm	Mortality % After 24 hr	Number of eggs in indicated veneer		
			Treated	Untreated	Total
Single	2000	97.5	2.5	—	2.5
	1000	90.0	4.0	—	4.0
	500	77.5	20.5	—	20.5
	125	42.5	34.8	—	34.8
	62.5	7.5	51.0	—	51.0
	31.3	0.0	28.0	—	28.0
	15.6	0.0	30.0	—	30.0
	7.8	2.5	28.8	—	28.8
Twin	2000	67.5	0.0	23.8	23.8
	1000	32.5	0.0	11.0	11.0
	500	60.0	2.5	30.8	33.3
	125	17.5	10.5	28.8	39.3
	62.5	2.5	9.8	25.8	35.6
	31.3	5.0	17.5	25.8	43.3
	15.6	5.0	30.3	41.8	72.1
	7.8	5.0	16.3	14.8	31.1
Single	Untreated	2.5	—	45.0	45.0

and the number of eggs in the single arrangement was significant at the 5% level ($r = -0.79$). In the twin arrangement, it was evident that the number of eggs was larger in the untreated veneer than in the treated one. For example, the numbers of eggs found in the treated and untreated veneers at 2000 ppm were 0 and 23.8, respectively.

Permethrin also showed a slightly lower mortality in the twin arrangement as did fenitrothion (Table 2). The number of eggs laid was very small at concentrations lower than those which showed lethal toxicity to adults in the single arrangement. For example, only one egg was found at 31.3 ppm, though the mortality was 2.5%. In the twin arrangement, permethrin allowed the adults to oviposit in the untreated veneers below 500 ppm, while it completely inhibited their oviposition at concentrations higher than 500 ppm. Only two eggs were found in the treated veneer even at 2.0 ppm in the twin arrangement. However, at the same concentration 17 eggs were laid in the single arrangement. Obviously, oviposition in the treated veneers was less in lower concentrations in the twin arrangement than in the single arrangement.

Lindane showed no difference in mortality between the single and twin arrangements (Table 3). A significant correlation ($r = -0.77$) between the mortality rate and the number of eggs was obtained at the 5% level in the single arrangement. In the twin arrangement, the number of eggs laid in both veneers was equivalent at every

Table 2. EFFECT OF PERMETHRIN ON OVIPOSITION OF *L. bruneus*

Arrangement	ppm	Mortality % After 24 hr	Number of eggs in indicated veneer		
			Treated	Untreated	Total
Single	2000	85.0	0.0	—	0.0
	1000	75.0	0.0	—	0.0
	500	60.0	0.0	—	0.0
	125	32.5	0.0	—	0.0
	62.5	12.5	0.0	—	0.0
	31.3	2.5	1.0	—	1.0
	15.6	2.5	1.3	—	1.3
	7.8	7.5	3.3	—	3.3
	3.9	5.0	10.8	—	10.8
	2.0	2.5	17.0	—	17.0
	1.0	2.5	27.0	—	27.0
Twin	2000	67.5	0.0	0.0	0.0
	1000	70.0	0.0	1.3	1.3
	500	40.0	0.0	1.8	1.8
	125	30.0	0.0	12.0	12.0
	62.5	5.0	2.5	10.3	12.8
	31.3	2.5	0.3	15.0	15.3
	15.6	0.0	0.3	9.6	9.9
	7.8	2.5	1.8	23.0	24.8
	3.9	0.0	3.5	37.0	40.5
	2.0	5.0	2.0	39.8	41.8
	1.0	5.0	8.3	16.5	24.8
Single	Untreated	0.0	—	29.8	29.8

Table 3. EFFECT OF LINDANE ON OVIPOSITION OF *L. brunneus*

Arrangement	ppm	Mortality % After 24 hr	Number of eggs in indicated veneer		
			Treated	Untreated	Total
Single	2000	100	0.0	—	0.0
	1000	80.0	0.3	—	0.3
	500	70.0	4.5	—	4.5
	125	15.0	14.8	—	14.8
	62.5	0.0	8.8	—	8.8
	31.3	0.0	18.5	—	18.5
	15.6	0.0	31.5	—	31.5
	7.8	0.0	10.0	—	10.0
	3.9	2.5	25.5	—	24.5
Twin	2000	90.0	0.5	1.8	2.3
	1000	80.0	1.5	1.8	3.3
	500	75.0	1.5	2.5	4.0
	125	5.0	8.5	7.0	15.5
	62.5	0.0	6.0	9.3	15.3
	31.3	2.5	21.5	25.3	46.8
	15.6	0.0	18.8	10.0	28.8
	7.8	2.5	13.0	25.0	38.0
	3.9	2.5	14.8	18.0	32.8
Single	Untreated	0.0	—	12.6	12.6

Table 4. EFFECT OF LINDANE ON OVIPOSITION OF *L. brunneus*

Veneer	Concentrations and number of eggs			
	30 ppm	15 ppm	7.5 ppm	3.5 ppm
Untreated	18.7	27.7	15.7	15.0
Treated	12.9	20.9	31.9	30.6
Total	31.6	48.6	47.6	45.6

Table 5. EFFECTS OF LINDANE ON MORTALITY OF THE ADULTS OF *L. brunneus*.

Treatment ^a	Concentrations and Mortality %		
	2000 ppm	1000 ppm	500 ppm
A	100	62.5	60.0
B	40.0	20.0	0.0

^a See the text.

concentration of lindane. Table 4 also shows that there was no significant difference in the number of eggs between the treated and untreated veneers. The former was treated with lindane at concentrations not toxic to adults. This meant that the adults oviposited equally in both treated and untreated veneers in the twin arrangement.

The effect of lindane vapor on mortality of the adults is shown in Table 5. The mortality at 2000 ppm was 100% in treatment A, in which the adults were contact

with the treated veneers, and 40% in treatment B, in which the adults were exposed to lindane vapor only. Evidently, there was a large difference in mortality between treatments A and B.

DISCUSSION

In the twin arrangement, no or few eggs were found in the untreated veneer when the other veneer was treated with permethrin at 500 ppm or over (Table 1). ITO and HIROSE (1979) reported that permethrin at 250 ppm showed rapid knock-down activity against the adults of *L. brunneus*, when applied on wood. In this experiment, it would also be expected that the adults would be poisoned and could not lay eggs, when in contact with the treated veneers. Namely, no or few eggs in the untreated veneers at 500 ppm or over may be due to the rapid poisoning of the adults. Permethrin in low concentrations, not lethal to the adults also inhibited oviposition in the treated veneers in the single arrangement. In addition, oviposition in the treated veneers was less in lower concentration in the twin arrangement than in the single arrangement. This demonstrated that when the adults were given the untreated and treated veneers at the same time, they selected the former for oviposition. For example, the adults laid 39.0 eggs in the untreated veneer, but only 2.0 eggs in the treated one at 2.0 ppm. It was evident that the adults avoided the treated veneers. HALL (1979) also observed a similar phenomenon caused by permethrin in the plum curculio *Conotrachelus nenuphar*. It may be concluded that avoidance of permethrin by the adults resulted in no or few eggs in the treated veneers at sublethal concentrations.

It is reasonable that mortality of the adults in the single arrangement is larger than in the twin arrangement, because the contact frequency of the adults with the treated veneer may be greater in the former than in the latter. However, lindane showed no difference in mortality between the two arrangements. The results shown in Table 5 eliminated the possibility that lindane vapor killed adults equally in both arrangements. If lindane attracts the adults, the absence of a difference in mortality could be explained. Because the contact frequency of the adults with the treated veneer may be equal regardless of the manner of arrangement. However, the absence of a difference in the number of eggs between the untreated and treated veneers was observed (Table 4). The absence of a difference in the number of eggs seems to eliminate this possibility. On the other hand, continuous observation of the adults in the petri dish revealed that they actively moved around. If lindane gave no negative stimulus to the adults, it would be expected that the adults laid eggs equally in the treated and untreated veneers. However, the absence of negative stimulation could not entirely explain the absence of a difference in mortality. Further research on the effect of lindane on oviposition seems necessary.

In the case of fenitrothion, the number of eggs was larger in the untreated veneer than in the treated veneer (Table 1). For example, the number of eggs in the untreated and treated veneers at 2000 ppm was twenty-four and 0, respectively, while the mortality was 58%. This suggests that only the adults which attacked the untreated veneer could lay eggs. In addition, a significant correlation between the number of eggs and the mortality rate was obtained. The lethal toxicity of fenitrothion seems to be a main factor governing oviposition of the adults.

ACKNOWLEDGEMENT

The authors wish to thank Prof. T. SAITO of Nagoya University for his helpful suggestions throughout this work. They are also grateful to Sumitomo Chemical Co, Ltd., for permission to publish this work.

REFERENCES

- HALL, F. R. (1979) Effects of synthetic pyrethroids on major insects and mite pests of apple. *J. econ. Ent.* **72** : 441-446.
- ITO, T. and C. HIROSE (1978) Observations on selective oviposition of *Lyctus brunneus* STEPHENS with reference to the influence of carbohydrate. *Jap. J. appl. Ent. Zool.* **22** : 68-73.
- ITO, T. and C. HIROSE (1979) Efficacy of some insecticides to egg, larva and adult of *Lyctus brunneus* STEPHENS *Jap. J. appl. Ent. Zool.* **23** : 46-48.
- ITO, T. and C. HIROSE (1980a) Effects of certain insecticides to *Lyctus brunneus* STEPHENS (Coleoptera : Lyctidae) *Appl. Ent. Zool.* **15** : 293-298.
- ITO, T. and C. HIROSE (1980b) Rearing of *Lyctus brunneus* STEPHENS on artificial diet. *Appl. Ent. Zool.* **15** : 496-497.