

## RESIDUAL ACTIVITY AND PERSISTENCE OF DELTAMETHRIN INSECTICIDE ON DIFFERENT SURFACES AGAINST SITOPHILLUS ORYZAE (L.) AND RHIZOPERTHA DOMINICA (F.)

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### Abstract

Residual activity and persistence of deltamethrin on different surfaces against *Sitophilus oryzae* (L.) and *Rhizopertha dominica* (F.) adults was investigated. Three rates of deltamethrin (0.4, 0.3 and 0.2 mg A.I /cm<sup>2</sup>) was applied to steel, ceramic tile, plywood and cement (wall or floor surfaces) and plastic, damour, polypropylene and jute (fabric surfaces). Adults were released on surfaces after 24 hrs. from application (0 time) then after oneweek interval during 6 months. The adult mortality percentages were recorded after 24hrs. from exposure. Results indicated that:

- The residual activity of deltamethrin against the two tested insect species adults was concentration, surface and time after application –dependent .
- Adults of *S.oryzae* adults were more susceptible than *R. domonica* with all detamethrin concentrations on different surfaces in all period intervals.
- Steel and ceramic surfaces with all concentrations of deltamethrin gave greatest residual activity with complete mortality for 6 months against the two insect species.
- Also, the residual effect of insecticide was high on plastic, polyethylene surfaces, followed with plywood and damour surfaces.
- Deltamethrin with cement surface deteriorated rapidly starting from the initial time and failed to give 100% kill to the two tested insect species.
- Also, values of gross persistence indicated that, non-porous surfaces ( steel ,ceramic, plastic and polyethylene ) were the most ideal to retain deltamethrin efficacy compared with the other porous surfaces.

### INTRODUCTION

Damages related to the insect infestations have created many problems in stored products especially in developing countries where poor hygiene and inappropriate use of storing equipment encouraged insect attack.

*S. oryzae* and *R. domonica* are the most important primary insect pests able to cause major losses to cereal grains affecting the quantity as well as quality of the grains.

It is a common practice in many developing countries to spray the fabric of stores and grain stores with residual formulations of contact insecticides to control stored-product insects. This is achieved by first killing the insects present, and

secondly by leaving a persistent deposit, which continues to kill insects arriving on the surface. (Hodges 1993) and (Hanlon *et.al.* 2000).

The surfaces commonly sprayed include walls, floor and bag-stacks, materials which are likely to be sprayed therefore are concrete, wood, metal and sacking such as jute, sisal, polypropylene and multi-wall paper. (Jordi *et.al.* 2007).

Insecticidal efficacy and persistence will vary depending on the type of surface, type of insecticide, species of insect insects or duration of exposure as documented in many studies on stored product insects. (Collin *et.al.* 2000, Jankuv *et.al.* 2013 and Rumbos *et.al.* 2014).

The aim of the study was to evaluate the residual efficacy and persistence of deltamethrin insecticide against *Sitophilus oryzae* (L.) and *Rhizopertha dominica* (F.) adults on steel, ceramic tile, plywood and cement (wall or floor surfaces) and plastic, damour, polypropylene and jute (fabric surfaces) after their application.

## MATERIALS AND METHODS

### **Insect species used:**

Two species of stored grain insects were used in this study, rice weevil, *Sitophilus oryzae* and the lesser grain borer, *Rhizopertha dominica* adults. Both were reared on wheat kernel cultures at  $27 \pm 1^\circ\text{C}$  and  $65 \pm 5\%$  RH and maintained for five generations.

### **Insecticide and surfaces:**

Commercial formulation of deltamethrin (Decis, 2.5 %E.C) insecticide was applied on the wall and floor surfaces i.e. (steel, ceramic tile, plywood and cement) and fabric surfaces i.e. (plastic, damour, polypropylene and jute). Individual discs were prepared by cutting a circular disc to fit Petri dishes (1.5 cm high  $\times$  9 cm diameter), while, cement discs were prepared by mixing 3200 g of cement in 1600 ml of water to a thick running consistency, which was subsequently poured into individual Petri dishes. 1ml of each concentration was applied on discs to obtain deposits of 0.4, 0.3 and 0.2 mg A.I/cm<sup>2</sup>.

### **Bioassay:**

To evaluate the persistence efficiency of deltamethrin on different surface against the tested insects, 50 adults of each insect species were released on surfaces after 24 hrs. from application (0 time) then introduced periodically at one week intervals up to 6 months after initial treatments.

In all cases, three replicates were made for each treatment. The mortality percentages were recorded after 24hrs. from adults exposure, and corrected with

Abbott's formula (1925). Gross persistency values were worked out according to the formula used by Power and Yadav (1980) as follows:

Gross persistency = sum of (% mortality × period days)/ Number of observations

## RESULTS AND DISCUSSION

Results concerning the residual effect and persistence of deltamethrin on different surfaces against *S. oryzae* (L.) and *R. dominica* (F.) adults are given in tables (1-4).

### **1- persistence of deltamethrin on wall and floor surfaces against *Sitophilus oryzae* adults:**

Data in table (1) showed that, all tested concentrations of deltamethrin gave 100% mortality from the initial time up to 6 months with steel and ceramic surfaces, meanwhile, same effect extended to 3 months at the highest concentration with plywood surface, then decreased gradually to reach 90% mortality at 6 months interval, while, the lowest concentration (0.2 mg/cm<sup>2</sup>) failed to give 100 kill during experiment period with sharp decline in mortality percentages to record 63.3% after 6 months.

On cement surface the residual activity of deltamethrin was poor and failed to give complete mortality even with the highest concentration from starting test, it gave (75.3%) at the initial time and reduced to 40.3% in 6 months interval.

These results agree with those findings by Hodges and Dales (1991) who reported that, increased absorbency of substrate is associated with poor levels of insecticide residual activity, also, David and Kenneth (1981) stated that, deltamethrin was effective at 12 and 12.5mg/m<sup>2</sup> against *S. oryzae* adults but the deposits were slower acting after 4 weeks.

### **2- persistence of deltamethrin on fabric surfaces against *Sitophilus oryzae* adults:**

Table (2) indicated that, there was negative correlation between the mortality values and the time after application. Results show that, plastic surface cause a complete prevention against *S. oryzae* adults for four months when treated with 0.4 mg/cm<sup>2</sup> of deltamethrin, respectively. After 6 months these values were decreased to 80.0, 70.0 and 54.7% for the aforementioned concentrations, respectively.

On damour surface, a complete mortality was extended for three months at 0.4 mg/cm<sup>2</sup> and one month at 0.3 mg/cm<sup>2</sup>, while at the lowest concentration this effect was decreased fast after the initial time to give 30.7% after 6 months from application.

At the same time, all adults were dead for three months when exposed to polyethylene surface treated with the two highest concentrations, while, the complete mortality was obtained at the initial time only with the lowest concentration.

These results are in harmony with the finding of Wasala *et.al.* (2016) Who found that, deltamethrin incorporated polyethylene bags exhibits a complete mortality to *S. oryzae* and *R. domonica* adults during paddy storage at ambient conditions.

On the other hand, jute surfaces with the highest concentration cause 100% kill of *S. oryzae* adults at the initial time then reduced gradually to reach 42.0% at 6 months interval.

The initial concentrations ( 0.3 and 0.2 mg/cm<sup>2</sup> ) gave 94.7and 86.0% kill, resp., then decreased to record 33.3 and 30.0% after 6months from application.

**3- persistence of deltamethrin on wall and floor surfaces against *Rhizopertha dominica* adults:**

The two highest concentrations of deltamethrin applied on steel and ceramic still to give 100% mortality for *R. domonica* adults up to 6 months, meanwhile, this effect prolonged for 4 months with the lowest concentration.

Plywood surface treated with 0.4 mg/cm<sup>2</sup> marked 100% mortality up to 1month only and decreased gradually to 70.0% mortality at 6 months interval, while, the other two concentrations gave (93.3 and 87.3%) at the initial time then decreased to reach after 6 months about (60.0and 50.0%). On cement surface, all concentrations of deltamethrin insecticide were deteriorated very rapidly and fail to give complete mortality at all test intervals (table 3).

Table1. Persistence of deltamethrin on wall and wool surfaces against *S. oryzae* adults.

surface	Conc. mg/m <sup>2</sup> Time.	(% ) adults mortality± S.D at various intervals							Gross persistence
		0	1	2	3	4	5	6	
Steel	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
	0,3	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
	0.2	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
Ceramic tile	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
	0.3	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
	0.2	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
Plywood	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	95.3±2.5	95.0±2.1	90.0±0.0	3377
	0.3	100.0±0.0	100.0±0.0	100.0±0.0	90.7±1.2	85.3±2.4	80.0±2.2	78.3±1.2	297.2
	0.2	84.7±3.1	80.0±1.6	75.0±2.0	70.7±2.1	66.0±2.5	65.3±2.1	63.3±0.9	235.4
Cement	0.4	75.3±1.2	72.0±2.2	70.0±1.6	64.7±1.2	54.7±1.7	40.7±1.6	40.3±1.2	170.8
	0.3	72.7±2.4	56.0±2.1	44.0±2.1	39.7±1.2	20.0±1.4	15.3±0.5	14.0±0.8	81.4
	0.2	60.0±2.2	46.0±1.4	28.7±1.2	20.0±0.8	15.3±1.2	14.0±0.8	00.0±0.0	58.9

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Table 2. Persistence of deltamethrin on fabric surfaces against *S. oryzae* adults.

Surface	Conc. mg/m <sup>2</sup>	(% ) adults mortality± S.D at various intervals							Gross persistence
	Time	0	1	2	3	4	5	6	
Plastic	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	85.3±1.7	80.0±1.6	317.8
	0.3	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	86.0±1.6	76.0±1.7	70.0±2.4	290.7
	0.2	100.0±0.0	100.0±0.0	100.0±0.0	93.3±1.2	64.0±1.6	58.0±2.4	54.7±2.1	242.4
Damour	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	94.0±2.4	65.3±1.7	55.3±0.5	272.4
	0.3	100.0±0.0	100.0±0.0	96.0±1.6	95.3±2.1	90.0±2.2	53.3±0.5	48.0±0.8	248.7
	0.2	100.0±0.0	91.3±1.2	88.0±2.2	80.0±0.8	56.0±1.6	44.0±1.4	30.7±1.2	189.3
Polyethylene	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	94.7±1.2	76.0±1.4	56.0±0.8	282.5
	0.3	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	90.0±1.6	66.0±1.4	50.0±0.3	269.0
	0.2	100.0±0.0	98.0±0.8	90.0±1.4	85.3±1.2	62.0±1.4	56.0±2.1	40.0±1.6	216.9
Jute	0.4	100.0±0.0	84.7±3.1	81.3±1.7	72.7±2.4	56.0±2.1	46.7±0.5	42.0±0.8	195.8
	0.3	94.7±1.2	68.0±0.8	56.7±0.9	56.0±1.6	50.3±2.1	44.0±2.1	33.3±1.2	187.1
	0.2	86.0±0.6	50.7±2.1.	43.3±0.9	40.7±1.7	36.0±0.8	30.7±1.2	30.0±1.6	147.2

Table 3. Persistence of deltamethrin on wall and wool surfaces against *R. dominica* adults.

surface	Conc. mg/m <sup>2</sup> Time.	(% ) adults mortality± S.D at various intervals							Gross persistence
		0	1	2	3	4	5	6	
Steel	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
	0.3	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
	0.2	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	92.0±0.5	90.0±0.8	330.0
Ceramic tile	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
	0.3	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	350.0
	0.2	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	95.0±0.8	94.7±1.7	340.5
Ply- wood	0.4	100.0±0.0	100.0±0.0	94.7±1.2	85.3±1.7	80.0±1.6	73.3±1.2	70.0±1.6	275.3
	0.3	93.3±1.2	86.0±0.8	80.0±0.8	68.7±0.9	65.3±1.2	63.3±1.7	60.0±1.6	231.6
	0.2	87.3±0.9	80.0±0.5	76.7±0.8	70.0±0.8	56.7±1.9	53.3±1.2	50.0±1.6	206.1
Cement	0.4	64.0±1.4	70.0±0.8	61.3±0.5	30.0±1.4	24.0±0.8	20.0±1.4	20.0±0.8	194.1
	0.3	50.0±1.7	41.0±0.8	33.0±1.2	22.7±0.5	12.3±0.9	8.7±0.5	0.0±0.0	144.6
	0.2	50.0±0.8	42.0±0.8	20.0±1.6	00.0±0.08	0.0±0.0	0.0±0.0	00.0±0.0	51.0

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Table 4. Persistence of deltamethrin on fabric surfaces against *R. dominica* adults.

surface	Conc. mg/m <sup>2</sup> Time	(% ) adults mortality± S.D at various intervals							Gross persistence
		0	1	2	3	4	5	6	
Plastic	0.4	100.0±0.0	100.0±0.0	100.0±0.0	100.0±0.0	90.0±1.4	85.3±1.2	72.7±2.4	303.8
	0.3	100.0±0.0	100.0±0.0	100.0±0.0	90.7±1.2	81.3±1.7	75.0±2.0	68.7±0.9	280.8
	0.2	100.0±0.0	95.3±2.5	87.3±0.9	78.0±0.8	68.7±0.9	66.0±2.5	48.0±0.8	232.8
Damour	0.4	100.0±0.0	98.0±0.8	93.3±1.2	91.3±1.2	88.0±2.2	86.0±0.8	78.0±0.9	301.4
	0.3	100.0±0.0	94.7±1.2	84.0±1.4	83.3±1.2	81.3±1.7	80.0±0.5	70.0±0.8	276.3
	0.2	100.0±0.0	90.7±1.2	82.0±2.1	80.0±1.6	76.7±0.8	73.3±0.5	62.0±1.4	256.7
Polyethylene	0.4	100.0±0.0	100.0±0.0	100.0±0.0	95.3±2.1	90.0±2.2	87.3±0.8	65.3±2.1	295.7
	0.3	100.0±0.0	100.0±0.0	100.0±0.0	87.3±0.9	82.0±0.8	78.7±0.5	56.0±2.1	269.9
	0.2	100.0±0.0	98.0±0.8	95.0±2.1	75.3±1.2	68.7±1.7	56.0±2.1	50.0±1.6	228.5
Jute	0.4	96.0±1.6	92.0±2.2	86.0±0.8	81.3±1.7	62.0±1.4	56.7±1.9	50.0±0.8	223.2
	0.3	88.0±0.8	72.0±1.6	66.0±2.5	58.0±1.2	48.0±0.8	37.3±0.9	30.0±1.6	156.1
	0.2	76.7±0.8	61.3±0.5	54.0±0.8	46.7±0.5	42.0±0.8	34.7±0.5	15.3±1.2	123.8



**4- persistence of deltamethrin on fabric surfaces against *Rhizopertha dominica* adults:**

The highest concentration of deltamethrin with plastic and polyethylene surfaces gave 100% kill up to 3 months. The same effect was obtained for 1 month only at the lowest concentration on polyethylene surface.

On the other hand, all concentrations of insecticide on damour and jute surfaces deteriorated very rapidly with time extension and were not sufficient to give complete prevention to *R. dominica* adults

**Gross persistence:**

The values of gross persistence for different surfaces tabulated in all tables indicated that, steel, ceramic tile, plastic and polyethylene surfaces were the most ideal to retain toxicity when compared with the other tested surfaces figures (1&2).

All results indicated clearly that, deltamethrin insecticide was more persistent on non-porous surfaces compared with porous surfaces.

These results are in harmony with the finding of Arther (1996) who proved that, efficacy of insecticide is best on non-porous surfaces such as steel and ceramic tile compared with porous surfaces, also, similar results had already been shown against *S. oryzae* and *R. dominica* using some surface treatments ( Mahgoub 1995 and Mahgoub *et.al.* 2013).

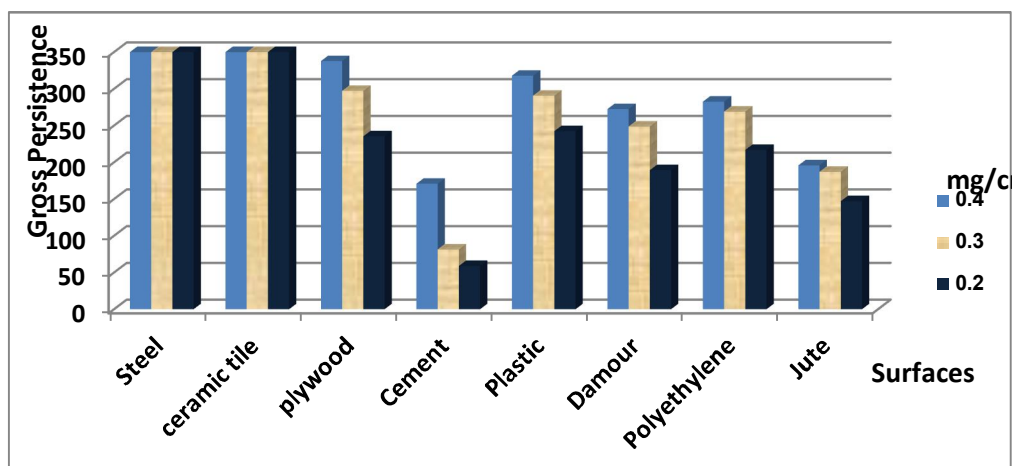


Fig.1.persistence of deltamethrin concentrations on different surfaces against *S. oryzae* adults.

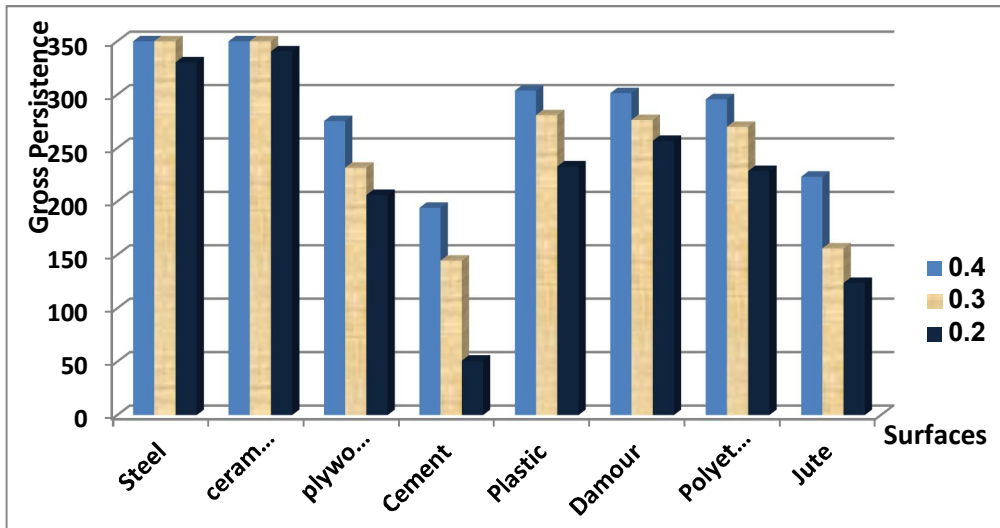


Fig.2. persistence of deltamethrin concentrations on different surfaces against *R. dominica* adults.

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## فاعلية وبقاء مبيد الدلتا مثرين على أسطح المواد المختلفة ضد حشرتي سوسة الأرز و ثاقبة الحبوب الصغرى

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معهد بحوث وقاية النباتات - مركز البحوث الزراعية - الدقي - مصر

- تم اختبار التأثير المتبقي لمبيد الدلتا مثرين ضد الحشرات الكاملة لكلا من سوسة الأرز و ثاقبة الحبوب الصغرى على أسطح مختلفة وهي أسطح الصفيح ، السيراميك ، الخشب والأسمنت (مثال لأسطح الحائط والأرضية) ، أسطح البلاستيك ، الدمور ، البولي اثيلين والجوت (مثال لأسطح العبوات والأغطية) بثلاث تركيزات ( ٠.٠٤ ، ٠.٠٣ ، ٠.٠٢ مجم مادة فعالة /سم<sup>٢</sup>) وتم تعريض الحشرات الكاملة لكلا النوعين بعد ٢٤ ساعة من المعاملة بالمبيد لحساب نسب الموت عند بداية التجربة ثم بعد كل أسبوع ولمدة ٦ شهور ، وأظهرت النتائج ما يلي :
- السمية و الأثر المتبقي للمبيد ضد حشرتي الاختبار تتوقف على تركيز المبيد،نوع السطح المعامل ، والوقت بعد المعاملة.
  - كانت حشرة سوسة الأرز أكثر حساسية من ثاقبة الحبوب الصغرى للأثر المتبقي من المبيد عند كل التركيزات وكذلك فترات الاختبار المختلفة.
  - كان أعلى بقاء للمبيد على سطحى الصفيح والسيراميك حيث أعطى موت كامل لحشرات الاختبار لمدة ٦ شهور بعد المعاملة.
  - كما كان هذا التأثير للمبيد أيضا عاليا على سطحى البلاستيك ، البولى اثيلين ،يليهما سطحى الخشب والدمور.
  - بينما حدث تدهور سريع من بداية التجربة لمبيد الدلتا مثرين على السطح الأسمنتى ولم يعطى موت لحشرات الاختبار بنسبة ١٠٠ %.
  - كما اوضحت نتائج عامل البقاء للمبيد أن الاسطح الغير منفذة مثل الصفيح ، السيراميك ،البلاستيك والبولى اثيلين كانت أفضل فى الحفاظ على بقاء فعالية المبيد مقارنة بالأسطح المنفذة الأخرى.