EFFICIENCY OF SELECTED CHEMICAL AGENTS FOR MOSQUITO CONTROL IN QALYUBIYA GOVERNORATE, EGYPT.

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INTRODUCTION

Several pathogens that affect human health are transmitted by mosquitoes and cause millions of deaths every year (Das *et al.,* 2007). Although different control strategies are in place for mosquito-borne diseases (vector) control is still considered an essential component of most disease control programs (Impoinvil *et al.,* 2007). Larvicides are more effective at controlling mosquito populations because larvae are in a confined area compared to widely disperse like adults.

Many insect growth regulator (IGRs) were evaluated and applied against the aquatic stages of mosquitoes in many countries. Methoprene have shown high level of activity against many species of mosquitoes and related groups with low toxicity (Silva and Mendes 2007; Kuo *et al.*, 2010). Methoprene mimics the function of JH and interferes with normal metamorphosis, resulting in larval mortality. Methoprene is commonly used for the control of larvae and has not been used as an adulticide, due to an absence of acute effects (Brabant 2012).

Monomolecular layers differ from other mosquito control agents because of their ability to target multiple stages in the mosquito life cycle (Batra *et al.,* 2006). All stages that come in contact with the water surface are affected by the lowered surface tension caused by such layers (Service, 2008). As a result, these layers can provide the combined benefits of larval and adult control, which leads to reduction in mosquito density and longevity (Killeen, 2003). Aquatain holds potential for mosquito control, especially in urban water-holding structures that are becoming increasingly popular in response to water conservation (Webb and Russell, 2009).

Chemicals used in adult control are mainly pyrethroids, and are highly effective against mosquitoes and show low toxicity to non-target organisms (Lee and Yap, 2003). Insecticide-treated materials (ITM) made from long-lasting

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insecticide-treated fabrics are expected to remain efficacious for longer periods than other chemical control measures (Vanlerberghe *et al.,* 2011).

The present work aims to evaluate the efficacy of the commercial formulation of Altosid XR briquette; the monomolecular surface film, Aquatain, and lambdacyhalothrin-treated curtains, were selected to assess their efficiency for designing of efficient strategies for mosquito control in Qalyubiya Governorate

MATERIAL AND METHODS

1. Field experiments

Field trials took place in pools at Atreeb area. Atreeb is located one km Northeast of Benha city, Qalyubiya Governorate (30°28' N 31°11' E) 55 km North of Cairo, Egypt. Selected pools are semi-permanent breeding sites with stagnant water.

The insect growth regulator (Altosid XR) and monomolecular surface film (Aquatain) were obtained from Clarke Mosquito Control Products, Inc., Columbia, South Carolina and Aquatain products manufactured by Aquatain products Pty Ltd, Australia, respectively.

Altosid XR extended residual briquette, a sustained release product to prevent adult mosquito emergence. This product contains water; therefore the weight of the briquette and percent by weight of active ingredient will vary with hydration.

Active constituent: (S)- Methoprene (isopropyl (2E,4E,7S)-11-methoxy-3,7,11-trimethyl-2,4-dodecadienoate

Application rates recommended: *Aedes* and *Psorophora* spp.: For control in non - (or low-) flow shallow depressions (≤ 2 feet in depth), treat on the basis of surface area, placing 1 briquette per 200 ft2. Briquette should be placed in the lowest areas of mosquito (*Culex, Culiseta,* and *Anopheles* spp) breeding sites to maintain continuous control as the site alternately floods and dries up.
(one Altosid XR Briquette per 100 ft^2).

Aquatain AMF is a unique liquid for mosquito control. It works by forming a very thin silicone film on the water surface, suffocating immature mosquito stages and disrupting the mosquito lifecycle. In some instances young wrigglers may still be present after treatment but these will be killed before they can develop into adults.

Active constituent: Polydimethylsiloxane 754 g/l.

Aquatain AMF is recommended for use in standing water in domestic/suburban areas such as gutters, ponds, blocked drains, water tanks, septic tanks and old tires.

Simply, a few drops to be squeeze on top the water (1- 2 ml per m^2 of water surface). Repeat application in 4 weeks.

Altosid and Aquatain were manually applied according to the recommended dose (¼ briquette/ m^2 and 1 - 2 ml/m^2, respectively). Larval and pupal densities were estimated in terms of larvae/dip (10 dips) before and after 24 hours of application. Water samples from the treated pools were collected daily for three days consecutively and after each three days interval and were bioassayed in the laboratory against *Culex pipiens, Cx. antennatus, Cx. vagans, Culiseta longiareolata, Aedes caspius* and *Anopheles multicolor* 4th instar. Larvae were tested in each replication with a similar number of un-treatment water sampled from the check pool and used as control. The percent reduction in mosquito larvae and pupae were calculated and the percent inhibition of adult emergence (%EI) was determined according (Mulla *et al.,* 1971)

The curtains (cotton and polyester) were impregnated with a synthetic pyrethroid insecticide (lambdacyhalothrin) at a minimum target impregnation dose of 10 ml/m^2 (Lengeler, 2009) and left to dry on plastic sheet for 1-2 hrs and 3-4 hrs for polyester and cotton curtains respectively. The treated curtains (cotton and polyester) were hanging down and covering the opening balcony's window of house. Curtains were made of polyester and cotton with holes of various sizes. Polyester mesh size (1.2 - 1.5 mm) and cotton curtains mesh size less than (0.2 mm) curtains were designed according to the size of balcony's window (1.0 × 2.0 m). To monitor utilization of the curtains (cotton and polyester) were hanging down and covering the opening balcony's window of house. The trial was conducted during June and September 2012. At morning, mosquitoes were collected from the house by mouth aspirator and counted (No of adults/room). Treated and untreated curtains were monitored for 12 and 6 additional nights in cotton and polyester curtains respectively. Impact of lambdacyhalothrin-treated curtains and untreated curtains on mosquito adults' entry to house was determined.

STATISTICAL ANALYSIS

Data were statistically analyzed using System Analysis Statistics (SAS) Program, version 6.12, 1998. The effect of chemical agents on mosquito population densities were studied using one way analysis of variance (ANOVA).

RESULTS AND DISCUSSION

Treatment in pools

Inhibition of adult emergence by Altosid is summarized in Table 1 and 2 and graphically illustrated in Fig. 2. Maximum percentage inhibition of adult emergence reached (96% and 94%) at 35 and 15 days post-treatment, respectively. Also, the percentage reduction in larvae and pupae were 70.1 and 94.4% at 35 days post-treatment, respectively during winter. While in summer, the percentage reduction in

larvae and pupae reached 50.1% and 86.6% at 35 days post-treatment, respectively. Thus, Altosid XR sustained-release briquette showed had long-lasting effect on mosquito population in winter than summer seasons, where it was effective for to 45 days. This may be due to effect of water temperature on Altosid reaction. High efficiency of Altosid was recorded by many investigators as Baruah and Das (1996) who found that Methoprene (Altosid) was eliminated 92-96% of *Culex* and *Anopheles* larvae for 1-3 months. Farghal (1987) who declared the persistence of Altosid lasted for 30 days with regarded to the briquettes, and 18 days for the WP formulation and Darabi *et al.*, 2011 when mosquito larvae are exposed to Altosid, their life cycle is disrupted and they are prevented from reaching maturity or reproducing.

Table (1)

Field evaluation of a commercial formulation of insect growth regulator, Altosid XR briquette against mosquito larvae and pupae in pools during winter season (February-March 2012).

Days post-treatment with Altosid briquette	Treated pool			Control pool		
	Mean No. of mosquito/10 dips (% reduction)		% inhibition of adult emergence	Mean No. of mosquito/10 dips		% inhibition of adult emergence
	larvae	pupae		larvae	pupae	
1	68 (21.9)	43 (10.6)	4	112	46	8
3	57 (36.8)	22 (34.0)	12	102	53	4
7	42 (52.4)	17 (70.2)	32	124	31	0
11	33 (66.6)	10 (84.0)	52	113	27	8
15	24 (75.0)	6 (89.6)	56	115	32	0
19	20 (82.1)	4 (88.9)	64	96	51	8
23	17 (84.3)	7 (77.4)	60	102	38	0
27	21 (88.5)	8 (87.1)	84	92	24	4
31	14 (90.2)	11 (83.8)	88	104	43	8
35	48 (70.1)	3 (94.4)	96	114	32	0
39	43 (58.4)	16 (86.6)	76	121	26	4
43	58 (39.9)	26 (67.5)	40	115	31	0
47	57 (29.6)	32 (42.3)	32	116	33	8
52	67 (23.7)	37 (29.3)	24	128	41	4
55	73 (8.6)	41 (14.5)	8	117	39	8

Table (2)

Field evaluation of a commercial formulation of insect growth regulator, Altosid XR briquette against mosquito larvae and pupae in pools during summer season (June-July 2012).

Days post-treatment with Altosid briquette	Treated pool			Control pool		
	Mean No. of mosquito/ 10 dips (% reduction)		% inhibition of adult emergence	Mean No. of mosquito/ 10 dips		% inhibition of adult emergence
	larvae	pupae		larvae	pupae	
1	77 (28.9) [b]	59 (20.6)	8	132	49	8
3	63 (36.8)	32 (34.0)	20	112	60	4
7	48 (52.4)	27 (70.2)	64	129	63	12
11	36 (66.6)	19 (84.0)	88	143	57	8
15	29 (75.0)	5 (96.2)	94	125	38	4
19	15 (91.6)	12 (89.9)	84	116	53	8
23	27 (84.3)	16 (83.4)	80	132	58	0
27	31 (82.5)	13 (86.9)	56	102	44	4
31	24 (86.9)	11 (73.8)	44	109	47	8
35	48 (50.1)	16 (86.6)	32	124	42	12
39	49 (53.4)	28 (67.5)	24	141	66	4
43	63 (39.9)	49 (41.3)	8	135	41	0
45	67 (14.6)	52 (19.0)	4	126	48	4

The monomolecular surface film, Aquatain had a long-lasting effect on mosquito populations at a dose of 2 ml/m^2 than 1 ml/m^2 in two natural pools at Atreeb area (Fig. 2A & B). Where it caused complete elimination of mosquitoes at 2 and 4 days post-treatment in winter season with stability for 19-13 days, respectively, while in summer it caused 92% and 84.2% reduction for 3 days post-treatment with stability for 9-7 days, respectively. (Stability means ≥50% reduction in mosquito population).

Our findings were agreed with Webb and Russell, 2009 who revealed that Aquatain caused 94.6% mortality for *Culex quinquefasciatus* and 33.6% for *Aedes aegypti* larvae and 100% mortality of pupae under laboratory conditions In 2010, the same authors conducted a field trial with the same product in Australia and revealed that a dose of 1 ml/m^2 of Aquatain caused more than 90% mortality of *Anopheles gambiae*, *An. stephensi* and *Culex quinquefasciatus* larvae and 55% mortality of *Aedes aegypti* larvae and 100% mortality in pupae within three hours.

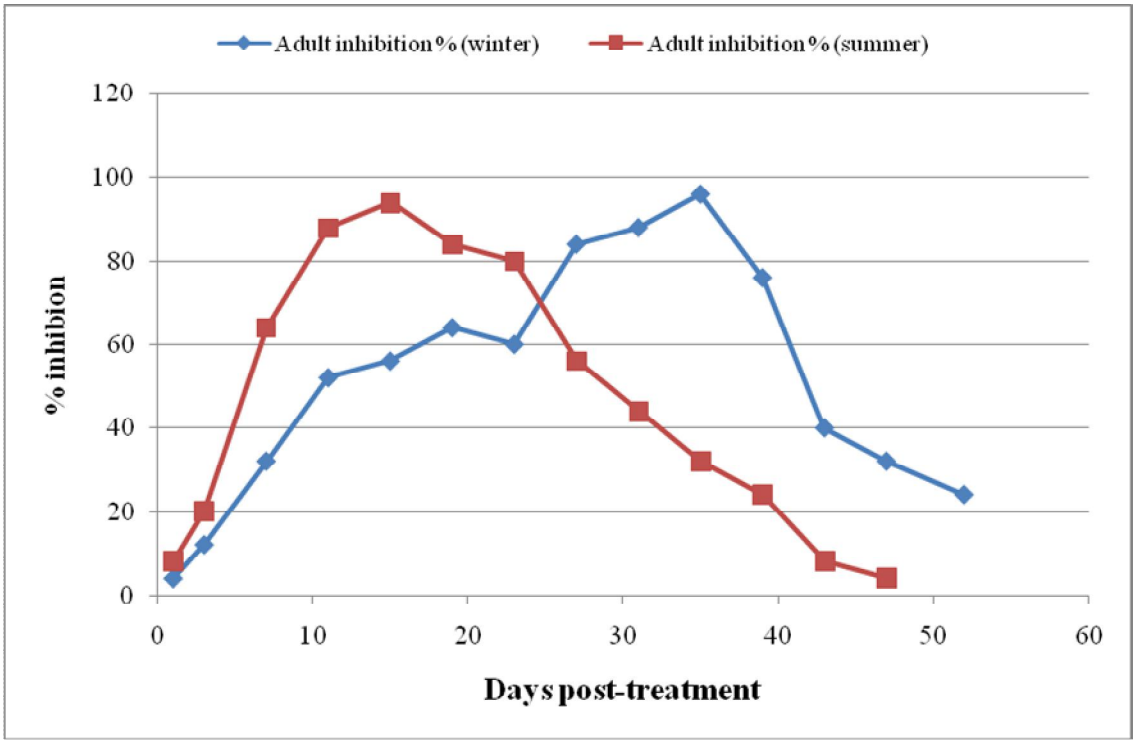
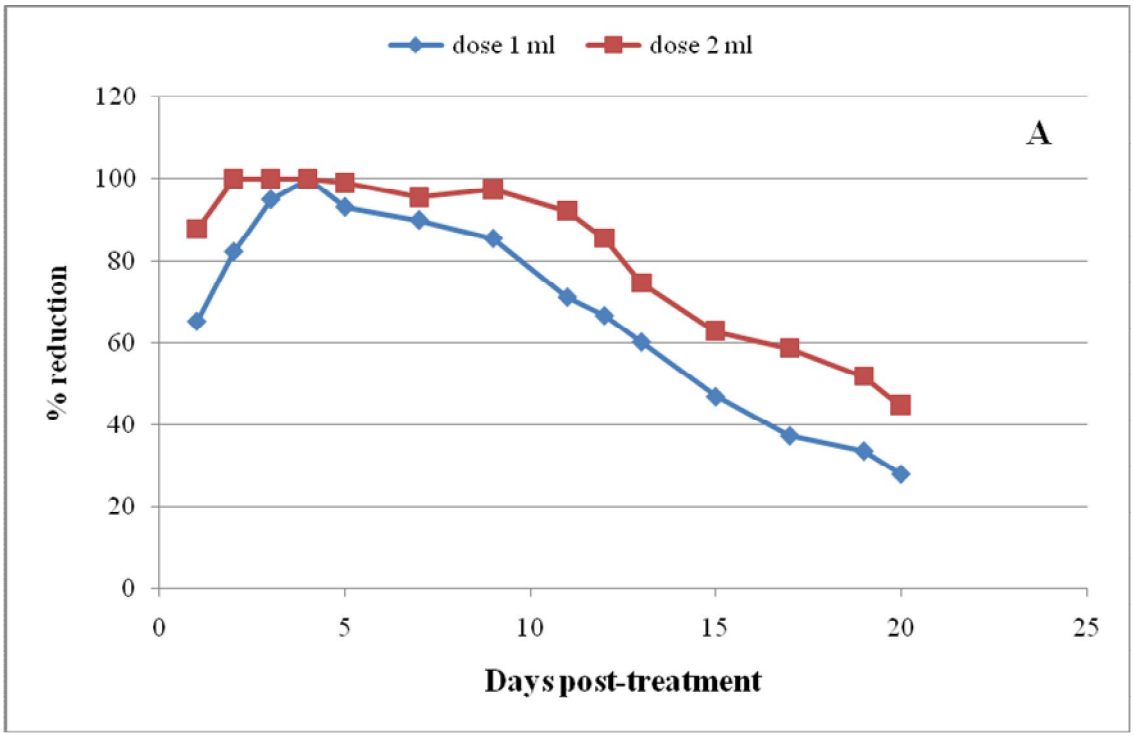


Fig. 1: Effect of Altosid XR briquettes on inhibition of adult emergence during winter and summer seasons in pools at Atreeb area Qalyubiya Governorate.

Treatment of curtains

The effectiveness of 10 ml/m^2 lambdacyhalothrin-impregnated cotton and polyester curtains in preventing the number of mosquitoes' entry in house is shown in Fig. 3 (A & B). Bedrooms of houses with impregnated curtains were completely protected from mosquitoes for one and two days in case of polyester and cotton curtains, respectively then the effectiveness was rapidly declined to reach a minimum after 5 and 10 days, respectively. Whereas the mean number of mosquito collected in case of treated and untreated cotton curtains was 13.8 and 35.0 respectively. While in polyester curtains the mean number of mosquito collected was 24.8 and 42.2 respectively. It is clear that the lambdacyhalothrin treated-cotton curtains was effective than treated-polyester curtains. This is may be due to the mesh size of cotton curtains is smaller than mesh size of cotton curtains.



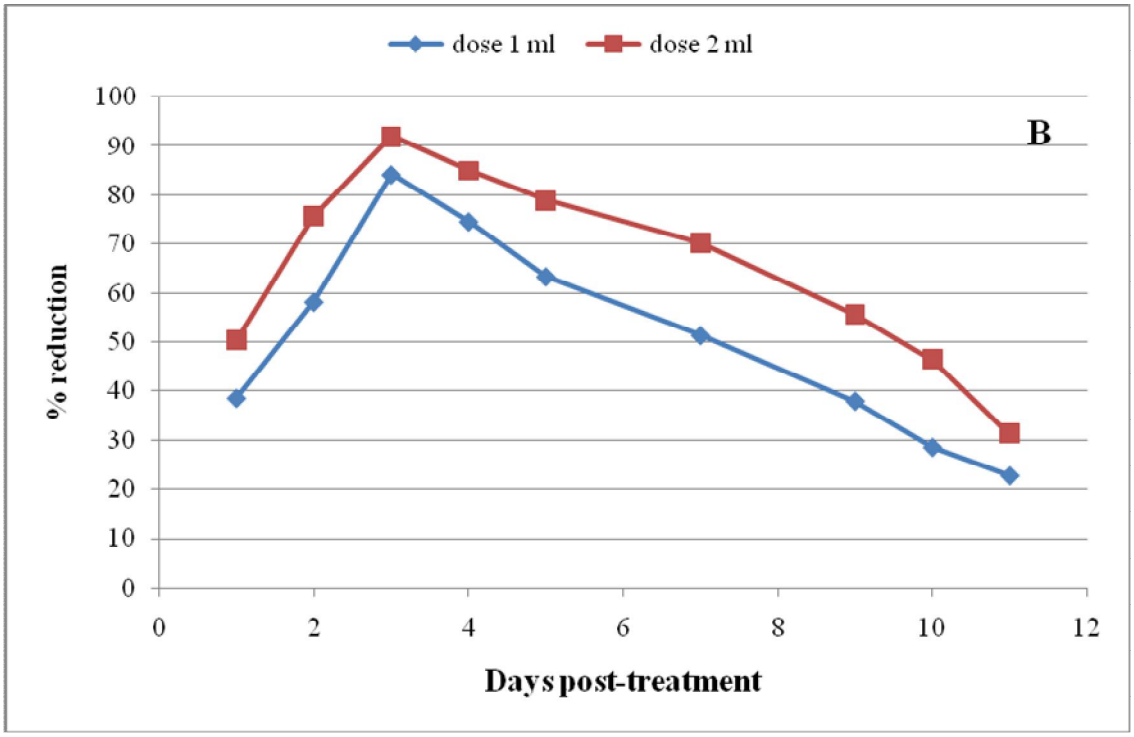
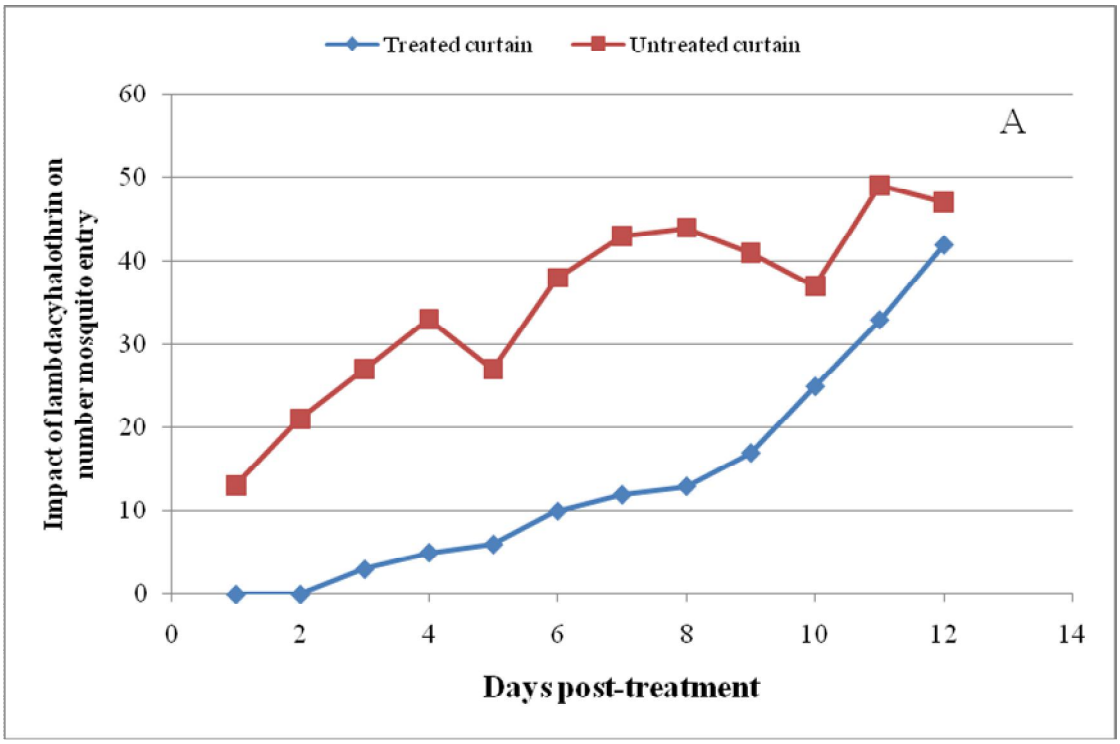


Fig. 2: Reduction in number of mosquito larvae and pupae treated with monomolecular surface film, Aquatain in pools during winter (A) and summer (B) seasons in Atreeb area, Qalyubiya Governorate.



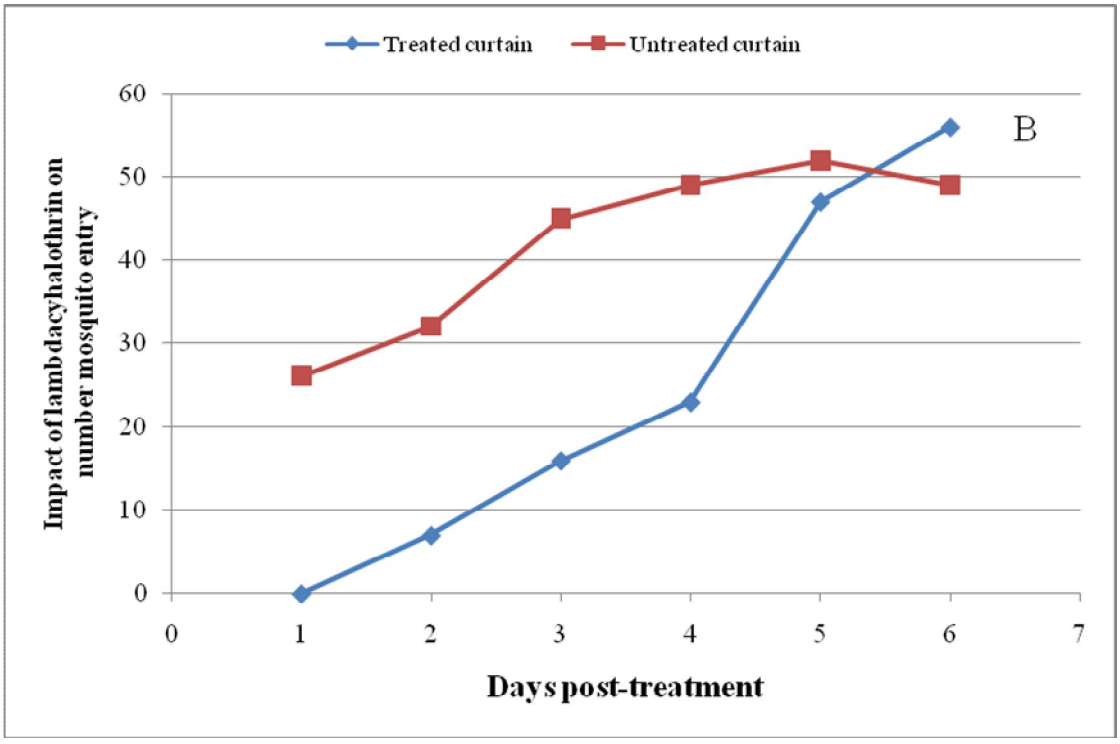


Fig. 3: Impact of lambdacyhalothrin-treated curtains and untreated curtains on number of mosquito adults' entry to house. Cotton (A) and polyester (B) curtains.

Similar findings were found by many investigators as Kroeger *et al.,* (2003) who stated that lambdacyhalothrin-impregnated bednets provided full protection of users and 100% mortality of mosquitoes. Kroeger *et al.*, (2008) showed that treated curtains window with lambdacyhalothrin can reduce densities of dengue vectors to low levels. On the other hand Vanlerberghe *et al.*, (2010) stated that the insecticide in the PermaNet curtains remains effective for at least one year and Lukwa *et al.,* (2012) showed that lambdacyhalothrin killed more mosquitoes than deltamethrin during 1-3 months post-treatment.

Finally we emphasize on the use of Aquatain in mosquito control in a wide variety of habitats such as canals, swamps, salt water marshes, ditches and sewage. All open habitats with 2 ml/m^2 from Aquatain are adequate to eradicate the mosquito immatures. From 1 ml/m^2 of pool surface Bukhari *et al.,* 2011 showed that Aquatain effectively and significantly controlled anopheline and culicine mosquitoes in rice paddies and aquatic places. Aquatain may be incorporated as a new control tool into integrated mosquito control programs.

SUMMARY

Field experiments were conducted in winter and summer seasons to study the efficiency of insect growth regulator (Altosid XR briquettes), monomolecular surface film (Aquatain) and synthetic pyrethroid insecticide (lambdacyhalothrin) and the extent of their impact in control programs. The efficacy of Altosid XR briquettes and Aquatain against culicine larvae and pupae was evaluated in selected pools under field conditions in Atreeb area, Qalyubiya Governorate. Altosid XR briquettes had long-lasting effect on mosquito population during winter than summer seasons. Monomolecular surface film, Aquatain had high effect on mosquito population at a dose of 2 ml/m^2 than 1 ml/m^2. The effect of treated-curtains with 10 ml/m^2 lambdacyhalothrin insecticide on inhibit mosquito adults' entry was determined by using treated cotton and polyester curtains. Cotton-treated curtains were suitable than polyester treated curtains.

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