

Efficacy of Sumilarv 0.5G - An Insect Growth Regulator - Pyriproxyfen, Against Mosquito Larvae in Kenya

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Abstract

Background: Malaria interventions particularly malaria vector control has gained popularity within the last twenty years. Sumitomo Chemical Company has developed a larvicide, Sumilarv 0.5G, based on the insect growth regulator -pyriproxyfen. SumiLarv 0.5G, unlike other larvicides, it has a novel mode of action and does not kill the larvae but prevents the emergence of adults by affecting the development of the larval and pupal stages. The study aimed at evaluating efficacy of Sumilarv 0.5G, an insect growth regulator- pyriproxyfen, against mosquito larvae in Kenya.

Methodology: Laboratory and field trials were carried out to determine the efficacy and residue effect of Sumilarv 0.5G against all mosquito species for the purpose of registration and use of this product in Kenya.

Results: Dosage of 2 g per 1000 liters of water was found to be effective in preventing adult mosquito emergence. The concentration of 2 g per 1000 liters measured as one teaspoonful was found to prevent re-infestation of the water by mosquitoes for a period of three months.

Conclusion: Sumilarv is recommended as a larvicide for the control of mosquito larvae and pupa if applied at above concentrations.

Keywords: Pyriproxyfen; Mosquitoes; Pest control; Insect growth regulator

Introduction

The scale up of malaria interventions particularly malaria vector control has gained popularity within the last twenty years with initiation of roll back malaria initiative in 1998 and the development of insecticide treated mosquito nets in nineteen eighties [1]. This together with scale-up of diagnostic testing and treatment has led to a 60% reduction in malaria mortality around the world and an estimated 33% drop in Africa alone [2]. There are two methods of malaria vector control; the distribution and use of long-lasting insecticides treated nets (LLINs) and indoor residual spraying (IRS), which have been implemented in malaria endemic countries and has resulted in significant reductions of malaria morbidity and mortality. These two malaria vector control interventions, IRS and LLINs target the adult indoor feeding and resting mosquitoes and both interventions are insecticide based [3-10].

In the view of rapid potential for mosquitoes to develop resistance to pyrethroid insecticides used to impregnate bed nets and chemicals used for IRS, new vector control tools are urgently needed. These are aimed to counter the increasing resistance that is threatening the effectiveness of existing insecticide-based interventions and to control malaria vectors not targeted by current interventions such as outdoor biters. There is a pressing need to re-evaluate the role of anti-larval measures for malaria control to scale up existing tools. Larviciding is a general term for killing immature mosquitoes by applying agents, collectively called larvicides, to control mosquito larvae and/or pupae [11-17].

This is in line with the recent developed policy guideline on management of insecticide resistance to safeguard the pyrethroids used on LLINs for long term use in malaria vector control. One of the recommendations on the policy guidelines is to use larval source management (LSM) as a tool of insecticide resistance management. LSM is also useful for controlling outdoor biting mosquitoes including day time biters such as *Aedes aegypti* which transmit various

arboviruses. This is in line with WHO recommendations which have indicated the member states may use larval source reduction where the mosquito breeding sites are few, fixed and findable.

The reviewed Kenya malaria strategy has included larval source reduction as one of the malaria vector control strategies [9,17-22]. However, there are very limited larvicides registered for use in Kenya, due low levels of uptake of this intervention by NMCP. Sumitomo Chemical Company has developed a larvicide, Sumilarv 0.5G, based on the insect growth regulator-pyriproxyfen. SumiLarv 0.5G, unlike other larvicides has a novel mode of action and does not kill the larvae but prevents the emergence of adults by affecting the development of the larval and pupal stages. We carried out laboratory and field trials to determine the efficacy and residue effect of Sumilarv 0.5G against all mosquito species for the purpose of registration and use of this product in Kenya.

Materials and Methods

The trials were conducted in two phases:

- (i) Laboratory phase,
- (ii) Field phase, both of which were conducted within Mwea rice irrigation scheme.

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Study area

The laboratory trials were carried out in Kimbimbi Vector-Borne Disease Control Unit (VBDCU) laboratory situated within Kimbimbi Sub-County Hospital. The laboratory is well equipped with equipment and well-trained personnel to carry out efficacy trials on insecticides for controlling various vectors of diseases. The laboratory is located within Mwea irrigation scheme, an area flooded year-round offering mosquitoes breeding throughout the year.

Laboratory phase

Larvae collection: The study team visited the area to identify natural breeding sites for *Anopheles*, *Aedes* and *Culex* mosquitoes. The sites identified for *Culex spp.* included stagnant drains (cement lined and unlined), pools, wetlands and irrigated fields. While for *A. aegypti* cement tanks, drums, cisterns and water storage containers were used. Garden pits, ponds, rice plots, stream pools, wetlands, marshes and seepages were identified for *Anopheles spp.* Sampling of various species of mosquitoes using a standard deeper was conducted.

Laboratory treatment: The samples of larvae collected were transported to the laboratory placed in mosquito rearing dishes for the purpose of this trial. The larvae were placed in plastic containers which were divided into three sets:

Set 1- 12 containers treated with SumiLarv 0.5G an insect growth regulator- pyriproxyfen at a dosage of 4 g per liter,

Set 2 - 12 containers treated with dimilin (diflubenzuron) an insect growth regular registered in Kenya at a dosage of 10 g/liter,

Set 3 - 6 containers untreated (control).

Thirty larvae were transferred into each of the plastic containers of 15 cms diameter containing water from their natural habitat. The containers were covered with untreated netting to prevent any emerging adult from escaping. Larvae survival or mortality, pupa formation and adult emergence was observed on daily basis and any morphological abnormality was recorded. Any dead larvae were also removed from the water daily. Mortality or survival was counted every day until all the larvae emerged into adults or were dead. The Sumilarv 0.5G for this trial was provided by Sumitomo Chemical Company of Japan through a local agent Quest Chemicals.

Field phase

For the purpose of field testing, various breeding sites in Thiba village, Mwea west sub-County were visited and sampled for mosquito breeding activities using a standard deeper to ascertain the presence of the larvae. Productive sites were recorded and larvicide was applied the following day. The identified breeding sites were temporary pools, drainage canals, man-made burrow pits and slow-moving streams. They were classified as temporary or permanent, geo referenced using GPS coordinates and classified based on vegetation cover as vegetated, lit or shaded. 48 such sites were sampled based on the mosquito breeding activities. The sites were divided into three sets:

Set 1- 20 sites treated with SumiLarv 0.5G,

Set 2- 20 sites treated with Dimilin,

Set 3- 8 sites untreated (control).

Field treatment: The selected breeding sites were treated with SumiLarv which was spread using hands and measured with a tea spoon. One tea spoon was approximated to two grams. The volume of

water was approximated in square meters based on the size of the water body/breeding site. A dosage of 0.02 g/m² was used in all the breeding sites.

Statistical analysis: Percentage inhibition of emergence of adults in treated containers was corrected for mortality in control containers. Mean percentage reductions of adults were compared with one-way ANOVA using SPSS version 20 to determine if inhibition of emergence varied significantly between the groups.

Results

Laboratory phase

Efficacy determination: Efficacy and residue activity of Sumilarv 0.5G was determined by counting the live larvae, pupae and emerging adults in the treated containers with SumiLarv 0.5G and the results were compared with the positive control treated with Dimilin, any abnormalities in the larvae or the pupae was also noted.

A total of 180 larvae were introduced into containers containing Sumilarv 0.5G and a similar number in containers containing dimilin larvicide. Another 180 larvae were introduced into the untreated containers (control). Mortality of the larvae in containers containing Sumilarv 0.5G increased significantly from day one and by day six all the larvae were dead and there was no pupae formation. In the containers treated with dimilin larvicide the mortality of the larvae was gradual, and all the larvae were dead by day seven and no pupae were formed. Mortality in control containers was very low with only 3.3% of the larvae dead by day twelve. Pupa formation was noted in the control containers from day four. This increased exponentially and by day twelve 96.6% of the larvae had emerged into adults. Generally, there was no significant difference ($p=0.8068$) in mortality rate between the containers containing dimilin and SumiLarv as compared to the control group ($p<0.001$). The results are as shown in the Figure 1.

Field phase

Efficacy determination: Efficacy and residual activity of Sumilarv 0.5G was determined by sampling larvae and pupa from the treated breeding sites, under natural conditions. The sampling continued every alternative day for a period of two weeks. Larvae observed in the breeding sites were not collected and were observed for any development in the natural habitat. Any pupa observed were picked and taken to the laboratory for further observation and to prevent any emerging adults from flying away. After two weeks sites were visited every three days for three months (90 days). Similarly, larvae and pupa were also sampled from breeding sites treated with Dimilin and the untreated control breeding sites. Any abnormalities in the larvae or the pupa were noted.

Out of 40 sites selected for treatment with either Dimilin (20 sites) or Sumilarv (20 sites) had various characteristics; shaded and permanent or lit and temporary. Majority, 16 (80%) of Sumilarv were temporary drains which were un-shaded while the remaining were permanent and shaded. This was well balanced with sites selected for Dimilin, 15 (75%) being temporary and lit while the remaining were permanent and shaded. The sites selected for control were 4 unshaded and temporary and 4 shaded and permanent.

During follow-up, seven sites dried up within the first three weeks. The dried sites were three in Sumilarv group which dried as one in week one and two in week three while the remaining four were in Dimilin group which dried up one in week two and three in week three. Some three other breeding sites had water levels increasing perhaps due to

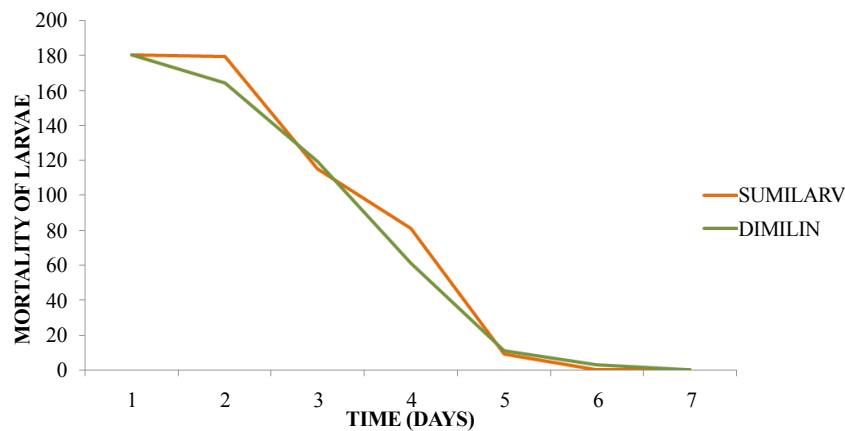


Figure 1: Mortality curve of mosquito larvae in water treated with insect growth regulator: SumiLarv and Dimilin.

	Collected pupae and 4 th instar larvae	Mean collection per site	Emerging adults
SUMILARV	140	7	0
DIMILIN	125	6.25	0
CONTROL	405	50.6	316

Table 1: Number of pupae collected in study sites and results of rearing them for emerging adults.

seepage from irrigated fields. These were sites 1 of Sumilarv group and site 2 of Dimilin group.

Compared to control, the two growth regulators prevented larva maturity and emergence of the adults. Overall 670 pupae were collected in 48 breeding sites within the first week of larvicide application. Sampling of study sites yield lower pupae among the treated sites compared to control. 20.09% of total collection from sites treated with Sumilarv compared to 18.7% of Dimilin treated sites. 60% of total collection was from untreated sites which were relatively few compared to 20 sites for each treatment arm. The mean pupae density in the treatment arm was 7 pupae per site among Sumilarv treated sites showed no significant differences ($p = 0.3685$) compared to 6.25 pupae per site in Dimilin treatment arm (Table 1). Attempts to rear pupae collected from these sites lead to 100% mortality in both treatment arm.

Follow-up

As a result of drying up, 33 treated sites were followed up for three months; 17 among the treatment arm of Sumilarv and 16 for Dimilin treatment arm alongside the 8 untreated sites. While mosquito breeding activities was observed in untreated sites with every sampling, none of the sites treated with either Dimilin or Sumilarv showed any sign of mosquito breeding. The sites however, had other biological organisms. Five out of 17 sites (29.4%) of Sumilarv sites had tadpoles while six out of 16 (37.5%) of Dimilin sites had tadpoles. Two sites of Sumilarv (11.2%) had fingerings.

Conclusion

Application of Sumilarv to mosquito breeding sites at a dosage of 2 g per 1000 liters of water was found to be effective in preventing adult mosquito emergence. The concentration of 2 g per 1000 liters measured as one teaspoonful was found to prevent re-infestation of the water by mosquitoes for a period of three months. Sumilarv does not seem to affect other biological organisms; tadpoles and fish fingerings were observed in treated permanent sites.

Recommendation

Sumilarv is an efficacious larvicide applied at 2 g per 1000 liters of mosquito breeding water. It is recommended as a larvicide for the control of mosquito larvae and pupa.

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