

Evaluation of IGR Compounds

Insect growth regulators (IGRs) are chemical compounds that are highly toxic to insect larvae or pupae, interfering with their development into adults. IGR compounds can be categorised as (a) Juvenile hormone analogues that prevent the development of larvae into pupae or of pupae into adults and (b) Chitin synthesis inhibitors which interfere with moulting process and kill the larvae when they moult. IGRs have a very low toxicity to mammals, birds, fish and adult insects, but are highly toxic to crustaceans and immature stages of aquatic insects. They break down rapidly in the environment but may last for several weeks/months when applied as granules, microcapsules or briquettes.

Hilmilin

Hilmilin is an insect growth regulator, highly effective against immature stages of mosquitoes and does not produce harmful effects on non-target organisms. Insecticidal activity of diflubenzuron, the active ingredient of Hilmilin is based on interference with the formation of chitin in insect cuticle, thus inhibiting the moulting.

Laboratory Evaluation

Hilmilin WP 25 and 22 SL formulations were dissolved in distilled water and laboratory reared larvae of *An. culicifacies*, *An. stephensi*, *Ae. aegypti* and *Cx. quinquefasciatus* were exposed to the Hilmilin and observations were made at 24 hours intervals till the emergence of adults and control was run concurrently. Four replicates of each concentration were tested. Different stages—larvae, pupae mosaics and incomplete emergence of adult was taken as dead pupae. LC_{50} and LC_{90} values were calculated as per standard procedure. Percent inhibition was calculated on the basis of untreated control run concurrently. Results of laboratory evaluation revealed that the Hilmilin formulations were highly effective against larvae of all the species tested. However, anopheline immatures were more susceptible than culicines. LC_{50} and LC_{90} values were 0.000869 and 0.0004775 (WP 25), respectively.

Field Evaluation

Tests were carried out in pools and unused wells against immatures of *An. culicifacies*, *An. stephensi* and *Cx. quinquefasciatus*. Hilmilin WP 25 and Hilmilin

22 SL @ 0.003 and 0.005 ppm, respectively were applied. The WP formulation was broadcast manually over the water surface, while 22 SL formulation was sprayed with the help of stirrup pumps. Observations were made till the emergence of adult. Field evaluation revealed that Hilmilin formulations showed varying degree of inhibition against mosquitoes. Cent percent inhibition of adult emergence was observed in *An. culicifacies* up to one week as against 95 and 93% in *An. stephensi* with two formulations. The persistence of the compound was also variable. The average percentage inhibition obtained @ 0.005 ppm WP 25 was 84.5, 83.16 and 75.16 up to 56 weeks against *An. culicifacies*, *An. stephensi* and *Cx. quinquefasciatus* as against 94.3, 92.0 and 82.5, respectively with 22 SL.

Diflubenzuron and Triflumuron

The IGR compounds Triflumuron and Diflubenzuron produced delayed impact (such as lesser pupal production and inhibition of adult emergence) at very low concentrations. Of the two products, Triflumuron displayed slightly higher toxicity against two mosquito species at EC_{50} level but at EC_{90} level, Diflubenzuron was slightly more toxic (EC_{90} = 0.0005 ppm) than Triflumuron (EC_{90} = 0.0024 ppm) against *An. stephensi*, while reverse was observed against *Ae. aegypti* (Table 3). At present IGR compounds are well in use as they do not pose any hazard to mankind and other wild life. These are also non-toxic against fish and can be used for prolonged antilarval effect.

Field evaluation

Both the formulations supplied by M/s. Crompton Uniroyal Chemicals Asia Pacific Pvt. Ltd., Mumbai, were tested for bioefficacy against immatures of *An. stephensi*, *Ae. aegypti* and *Cx. quinquefasciatus* vectors of urban and rural malaria, dengue and dengue haemorrhagic fever (DHF) and filariasis respectively in small field condition in the respective habitats of different species in and around Delhi.

Dilmilin TB-2% was applied in contained water habitats such as tanks and moderately polluted small pools on volume basis and Dimilin GR-2 formulation was applied on the surface area basis. Water sample from treated habitats was brought to the laboratory

Table 3. Toxicity of insect growth regulators formulation against *An. stephensi* and *Ae. aegypti*

IGR formulation	Concentration in ppm (mg/l)		
	LC/EC values	<i>An. stephensi</i>	<i>Ae. aegypti</i>
Diflubenzuron (25% WP)	EC ₅₀	0.0002	0.0004
	EC ₉₀	0.0005	0.0033
Triflumuron (48% SC)	EC ₅₀	0.0001	0.0002
	EC ₉₀	0.0024	0.0026

on the same day and after three days and later at an interval of one week. Laboratory colonised late III instar larvae were introduced in subsequent weeks till the complete pupation or adult emergence under controlled conditions. Also late instar larvae collected from the treated habitats were observed till the complete pupation or adult emergence under controlled conditions. Percent inhibition was calculated on the basis of untreated control run concurrently.

Dilmilin TB-2%, applied at half tablet and 1 tablet per 40 litre water (equivalent to 0.5 and 1 ppm) produced complete inhibition of the development of pupae and emergence of adult mosquitoes of *An. stephensi*, *Ae. aegypti* and also *Cx. quinquefasciatus* up to four weeks of observation in tanks with clear water, and *Cx. quinquefasciatus* in moderately polluted small pools.

The efficacy of Dimilin GR-2 formulation in

cement tanks when treated @1.5 kg/ha also showed 100% inhibition of *An. stephensi*; *Ae. aegypti* and *Cx. quinquefasciatus* up to four weeks. However, at lower dose, i.e. 1 kg/ha, 100% inhibition was observed against *Cx. quinquefasciatus* up to three days only, whereas against *An. stephensi* and *Ae. aegypti* only 97 and 96% inhibition was observed

Field evaluation of Dimilin GR-2 against *Cx. quinquefasciatus* larvae in pools produced 100% inhibition of adult emergence up to two weeks @ 1.5 kg/ha but at lower doses only 86 and 89% inhibition was observed on Day 3 itself which declined to 73 and 81% after four weeks.

The study revealed that the tablet and granule formulations of Dimilin were effective in the prevention of adult emergence of mosquitoes even at very low dosages. Of the three species tested, *An. stephensi* was most susceptible followed by *Ae. aegypti* and *Cx. quinquefasciatus*. □