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Effectiveness of Diflubenzuron in the control of houseflies

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Abstract

Background & objectives: Houseflies are one of the major pest problems worldwide. The current housefly control strategy in the country hinges on the use of Dichlorvos as a housefly larvicide and pyrethrum spray in kitchens/dining areas. The present study was undertaken to evaluate the newer housefly control options in the wake of concerns about human toxicity of Dichlorvos and its continued use in public health.

Methods: Efficacy of Diflubenzuron WP and granule formulations (chitin synthesis inhibitor) *vis-à-vis* Dichlorvos EC in the control of housefly was assessed in laboratory by adult emergence inhibition after treatment and in field conditions by estimation of density post-application up to three weeks using standard methods.

Results: Dichlorvos EC and Diflubenzuron formulations (WP and granule) brought about 100% inhibition of adult emergence under laboratory conditions. However, in the field evaluation, effective suppression of housefly population was brought about by Dichlorvos and Diflubenzuron granule formulation (though delayed).

Conclusion: Dichlorvos EC and Diflubenzuron granule formulation are effective housefly larvicides. It is recommended that Diflubenzuron WP formulation be evaluated at a higher frequency to enhance its effectiveness and its use may be considered in conjunction with an initial suppression of housefly adults with an adulticide, e.g. Cyphenothrin, etc.

Key words Dichlorvos; diflubenzuron; housefly; larvicide

Introduction

The housefly, *Musca domestica* L is a well-known cosmopolitan pest. It has a worldwide distribution and is found throughout the country in close association with human activities. It receives the common name of housefly by virtue of being the most common fly found in and around houses[1]. In addition to being a nuisance pest, it is a vector of many pathogens. It is a carrier of over 100 different pathogenic organisms including organisms for diseases, viz. typhoid, cholera, bacillary dysentery, tuberculosis, anthrax, ophthalmia neonatorum and infantile diarrhoea as well as parasitic worms[2–10]. Pathogenic organisms are picked-up by the flies from garbage, sewage and other sources of filth and transferred to human food either mechanically from contaminated external body parts or after consumption by houseflies through vomiting and defecation while feeding on food.

The control of *M. domestica* is thus, vital to human health and comfort. The common control measures are sanitation, use of traps and insecticides. However, in some instances integrated fly control has been implemented and found successful. The development of resistance in houseflies to insecticides and the associated toxicity has necessitated evaluation of safer alternatives for housefly control. The use of safer alternatives like biological control or insect growth regulators (IGR) is thus gaining attention as an important intervention in housefly management programmes[11,12].

Amongst the IGRs, chitin synthesis inhibitor — Diflubenzuron has been found quite effective against multi-resistant *M. domestica* strains. In the housefly, Diflubenzuron evokes ovicidal effects by topical application to adult females by oral uptake or by injection of the compound and has been documented to cause mortality in early larval stages. Treatment with Diflubenzuron was neither found to influence the fecundity of the females nor had an effect on the fertilization of eggs[13].

The present study was undertaken to evaluate Diflubenzuron, a chitin synthesis inhibitor, as a housefly larvicide *vis-à-vis* Dichlorvos, an organophosphorous insecticide routinely used as a housefly larvicide.

Material & Methods

The study was undertaken in the premises of a tertiary care hospital, which houses a large number of dining messes for its personnel with a number of garbage disposal points in its premises. Laboratory and field trials were carried out to evaluate the efficacy of the two formulations of Diflubenzuron (WP and granule) *vis-à-vis* Dichlorvos EC. Diflubenzuron is available as 25% WP and 5% granule formulation. The WP and granule formulations are recommended @0.5–1 g a.i./m^2 and @1–2.5 g a.i./m^2 respectively at fortnightly intervals sprayed @ 500 ml/m^2. A higher dosage of Diflubenzuron i.e. 1 g a.i/m^2 for WP and 2.5 g a.i./m^2 for Granule formulation was used in the present study as large amounts of garbage was being dumped thrice a day in the bins due to a large number of messes with a high turnover operating in the study premises. A higher dosage is ideally recommended in such cases to control houseflies especially in outdoor locations as found in the present study. These two formulations of Diflubenzuron were compared with Dichlorvos EC for efficacy as a larvicide. Dichlorvos is available as 76% EC and is recommended for use as a housefly larvicide on garbage bins as 0.5% spray sprayed @500 ml/m^2 at weekly intervals.

For the trial, all the cookhouses and garbage bins of the messes operating in the premises were included. Prior to initiation of the trial, various messes and their staff were briefed about the trial and were told to stop forthwith all chemical or any other control measures employed by them against houseflies other than general sanitation measures routinely undertaken by the messes. The pretreatment density assessment was undertaken in all the messes and garbage collections to ascertain the level of infestation.

Laboratory trial: For the laboratory trial, the treated garbage (garbage treated with Diflubenzuron WP, Granules and Dichlorvos EC at the recommended higher dosage for outdoor treatment i.e. 1 g a.i./m^2 and 2.5 g a.i./m^2 for Diflubenzuron WP and G formulation respectively and 0.5% in case of Dichlorvos sprayed @ 500 ml/m^2) from the garbage bins with active fly breeding was brought to the laboratory and placed in emergence chamber and observed for fly emergence. Garbage from untreated sites formed the control arm of the experiment. Each treatment was replicated five times with two controls each. The emergence inhibition (EI) of adults from the treated garbage was calculated by the method described by Mulla *et al*[14]:

$$EI = 100 - \{T/C\} \times 100$$

Where, T = Number of emerged flies in the treated group; and C = Number of emerged flies in the control group.

Field trial: The larvicides—Diflubenzuron WP (1 g a.i./m^2) and Dichlorvos EC (0.5%) were sprayed on the garbage as well on the sides of the container and the entire garbage bin at fortnightly and weekly intervals respectively. The spraying at the recommended rate i.e. 500 ml/m^2 led to wetness reaching up to a depth of about 1–2 inches of the breeding substrate when the substrate was not too dry. Diflubenzuron granules (2.5 g a.i./m^2) were broadcast on garbage collections at the recommended frequency, i.e. fortnightly interval and the residual efficacy of the treatments was assessed up to 21 days post-treatment.

Density estimation: Fly density was estimated weekly with a Scudder-grid (45 x 45 cm) using the method of Murvosh and Thaggard[15]. The grid was placed where there were natural fly concentrations and the number of flies landing on the grid were counted for a period of 60 sec. In each location, counts were made on three to five areas with the highest fly concentration after every 10 sec and then the counts were averaged to give the fly density. Grid count was considered acceptable when the variation between average grid counts per site was minimal during each sampling period. Each treatment was replicated three times with two controls per treatment. The percent reduction in density was calculated by the method of Mulla *et al*[14].

$$\text{Percent reduction} = 100 - \{C1/T1 \times C2/T2\} \times 100$$

Where, C1 = Number of houseflies in the control area prior to initiation of treatment; C2 = Number of houseflies in the control area post treatment; T1 = Number of houseflies in the treatment area prior to initiation of treatment; and T2 = Number of houseflies in the treatment area post treatment.

Results

All the garbage dumps in the study premises were either subjected to treatment or earmarked as control for the entire duration of the study. The field trials were conducted simultaneously with all the insecticides and corresponding controls. The results of the laboratory and field trial are as under.

Laboratory trial: The result of laboratory evaluation of housefly larvicides Diflubenzuron (WP and Granule) and Dichlorvos EC is presented in Fig 1. The adult EI was found to be 100% for all the insecticides under trial.

Field evaluation: The field evaluation of the larvicides is presented in Fig. 2. The results indicate a greater reduction (82.6%) in fly density in the first week post-treatment in case of Dichlorvos, whereas the fly density reduced only by about 51% in Diflubenzuron WP treated areas with a very marginal reduction in fly density (11.11%) recorded in Diflubenzuron granule treated areas in the same period. The percent reduction in fly density gradually increased in the second week post-treatment in respect of Dichlorvos (90%) and Diflubenzuron WP treated areas (53%), however, in Diflubenzuron granule treated areas, the fly density was found to increase rather than decrease in the second week post-treatment. The third week post-treatment recorded a sharp reduction in fly density in Diflubenzuron granule treated areas to the tune of about 88% whereas in the Dichlorvos treated areas, the reduction slightly declined to 86% in comparison to second week's performance of 90% reduction. The Diflubenzuron

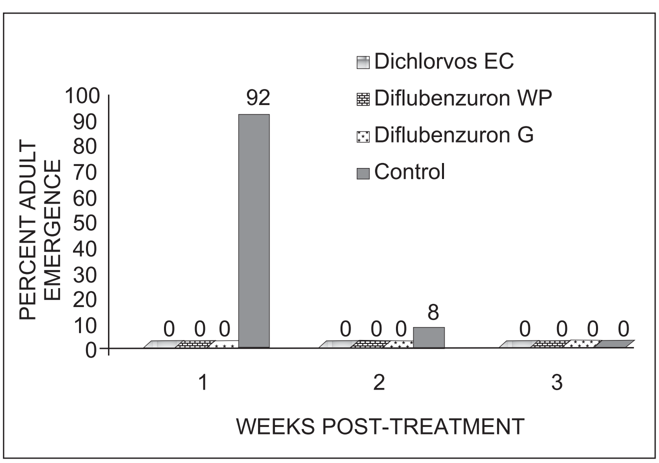

Fig. 1: Laboratory evaluation of efficacy of Diflubenzuron formulations and Dichlorvos in inhibiting emergence of housefly adults

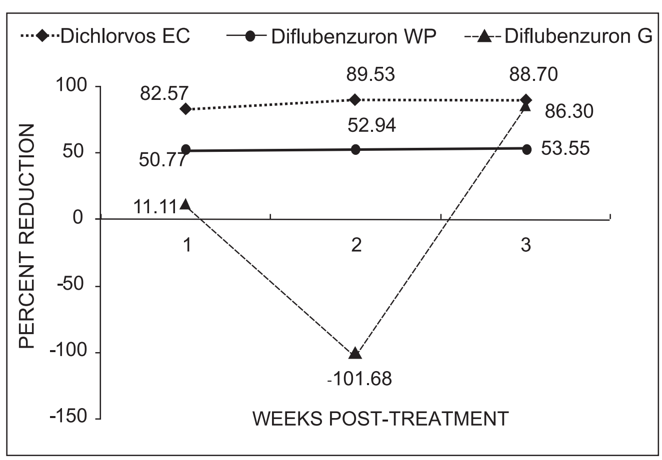

Fig. 2: Field evaluation of efficacy of Diflubenzuron granules and WP formulation vis-à-vis Dichlorvos EC in housefly larval control

WP treated areas continued to record nearly the same level of reduction, i.e. about 53%. The overall performance of Dichlorvos was found to be significantly better as compared to the other larvicides evaluated in the study.

Discussion

Housefly control poses a formidable challenge to vector control experts as well as householders engaged in combating the ever increasing nuisance of houseflies in residential areas, messes and other catering establishments. The development of resistance amongst houseflies to commonly used insecticides has necessitated evaluation of newer strategies for its control. The 100% EI exhibited by the two formulations of Diflubenzuron (WP and granule) and Dichlorvos EC, when evaluated under laboratory conditions indicates the efficacy of all the products under trial in suppressing fly population through larvicidal activity. However, the conditions maintained in the laboratory trials are ideal and controlled and such conditions may not exist in actual field situations[12,16]. The efficacy of Dichlorvos as a housefly larvicide has been clearly brought out by the findings of the field evaluation study; the same is a well established fact and has been reported by other workers as well[17,18]. Both the formulations of Diflubenzuron had a delayed impact on the fly density, especially treatment with WP formulation not resulting in the desired level of housefly control in field conditions. Other workers have however, reported better efficacy of the WP formulation when used at the same dosage, i.e. @ 1 g a.i./m^2 area in outdoor garbage points[19]. The probable reason for only a marginal reduction in fly density with Diflubenzuron WP formulation in the present study possibly is due to the excessive dumping of garbage in the bins, i.e. thrice a day which possibly led to reduced availability of the insecticide to the housefly larvae . The increase in fly density in Diflubenzuron granule treated areas in the second week post-treatment also might have been due to the non-availability of the insecticide due to large quantities of garbage being dumped in the bins, however, as this formulation does not suffer from runoff problem, it has yielded better efficacy as compared to WP formulation in the present study conditions. The better efficacy of Diflubenzuron granule formulation as compared to WP formulation has also been reported by other workers[20], even when used at a much lower dosage of 1 g a.i./m^2 as compared to 2.5 g a.i./m^2 used in this study.

The reasons for the better efficacy of the reduced dosage of this formulation in other studies might be due to moderate garbage accumulation coupled with less frequent dumping of garbage in the bins, unlike the uncontrolled dumping of garbage in outdoor locations existing in the present study. Though Diflubenzuron formulations were found effective in laboratory conditions, the performance of both the formulations of Diflubenzuron in field conditions needs to be viewed in the light of the fact that large quantities of garbage was being dumped in the garbage bins thrice a day which probably reduced the availability of the insecticide to the housefly larvae.

It is an accepted fact that Diflubenzuron is slow acting and hence takes time in bringing about the desired level of larval control. In this situation, when the garbage turnover is so high, an increase in frequency of spraying from fortnightly to weekly initially may bring about the desired level of reduction in housefly density. It is a well established fact that the frequency of application of an insecticide should not only be related to the speed of fly development, but also to the quantity of garbage dumped into the bins. When more garbage is put into the bins, the frequency of application should also be increased. Sufficient water should also be applied to penetrate into/between the waste food.

The present study has thus brought out two very important findings. Firstly, the recommended frequency of application of Diflubenzuron needs to be kept flexible (i.e. weekly to fortnightly) in due consideration to the quantity of garbage dumped especially in outdoor locations for effective housefly control. Secondly, it is also important that the quantity of diluent, i.e. water needs to be increased to bring about greater penetration of the insecticide in the breeding substrate. It is thus advisable to ensure that the treated area is soaking wet to the point of runoff while treating. The increase in frequency of application of Diflubenzuron along with an increase in the quantity of diluents however, needs to be evaluated in actual field situations and the results analyzed to assess whether this can really address the issue and bring about the desired level of housefly control and also be cost-effective.

At this juncture, the decision whether to continue Dichlorvos as a housefly larvicide, in housefly control strategies, based on the findings of the study necessitates more elaborate discussion and deliberation given the reports of emergence of tolerance amongst houseflies to Dichlorvos[21], the environmental concerns due to its toxicity and the likely withdrawal of the product for use in public health. This new development has necessitated introduction of alternative larvicide for housefly control to enable rotation of chemicals and retard development of resistance amongst houseflies. In the absence of a viable alternative as of now, it is advisable to continue Dichlorvos in the list of hygiene chemicals for housefly control till the frequency of application of Diflubenzuron is not validated in field settings and found effective in the control of houseflies.

With this background, it is recommended that Diflubenzuron formulations be evaluated in field at a higher frequency initially to bring about effective suppression of housefly populations. The product being a safe and specific insecticide may not pose environmental concerns even if the frequency of application is increased[12]. It may also be worthwhile considering an initial suppression of adult houseflies by an adulticide followed by larvicidal action with Diflubenzuron for an effective and long lasting management of houseflies.

In conclusion, it is considered that a more rational approach to housefly control as of now may be to opt for a judicious application of an adulticide like Cyphenothrin initially to bring down the adult fly density, followed by larvicidal control using Diflubenzuron granules in garbage dumps with high turnover of daily garbage, coupled with sound sanitation measures for a long lasting solution to fly menace. Dichlorvos may be reserved as a housefly control option for use in emergencies.

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