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Short communication

# Tolerance of house fly, *Musca domestica* L. (Diptera: Muscidae) to dichlorvos (76% EC) an insecticide used for fly control in the tsunami-hit coastal villages of southern India

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**Abstract**

The Directorate of Public Health (DPH), Tamil Nadu, in southern India employed spraying of dichlorvos (76% EC) for quick elimination of fly concentrations in the tsunami-hit coastal villages at the concentration of 304 g (a.i.)/10,000 $m^2$. However, nuisance of house flies remained high particularly in temporary shelters and centralized relief kitchens. Susceptibility of house fly, *Musca domestica* to dichlorvos was determined in the laboratory to provide information for an effective management of this pest. Various concentrations of dichlorvos (76% EC) viz., 0.1, 0.2, 0.4, 0.6 and 0.8 μg (a.i.) per fly, were tested using topical application against $F^1$ progenies of house flies collected 12 months after insecticide applications from different habitats in the tsunami-hit coastal villages. Fly mortality was recorded at 24 h post treatment. Parallel controls were maintained for comparison. Mortality of the house flies varied between 17.5% and 100% and increased with an increase in dosage of the insecticide. Mortality was >80% at 0.6 and 0.8 μg (a.i.) per fly. The $LD_{50}$ of dichlorvos tested against flies collected from different villages varied from 0.218 μg (a.i.) to 0.235 μg (a.i.) per fly and the $LD_{90}$ varied from 0.574 μg (a.i.) to 0.639 μg (a.i.) per fly. House flies collected from a rural village, Thirukanur that had never been exposed for insecticide treatment in the past one decade, when tested, the mortality varied between 92.5% and 100% and increased with concentration of dichlorvos. Mortality was >90% from 0.2 μg (a.i.) per fly and the $LD_{50}$ was 0.0399 μg (a.i.)/fly, while the $LD_{90}$ was 0.1604 μg (a.i.)/fly. The $LD_{90}$ values of the flies collected from the tsunami-hit villages were 3.5–3.9 times higher than that of the flies collected from Thirukanur. Fly abundance remained high in tsunami-hit villages with no marked reduction, suggesting that the flies had developed tolerance to dichlorvos. It is suggested that for an effective management of these resistant populations changing insecticides, application of unrelated insecticide, together with an appropriate environmental sanitation measure is necessary to keep the population under check.


*Keywords:* Dichlorvos; Fly resistance; Fly control; Southern India; Tsunami-affected coastal villages

## 1. Introduction

House fly, *Musca domestica* L. (Diptera: Muscidae), is synanthropic in behavior and has close guild with man (Harwood and James, 1969). It feeds and breeds on filth materials, frequent human habitations, and disseminating pathogenic organisms through contamination of food and drinks. Hence epidemics of fly-borne diseases are common, where human and fly populations are in high concentration, coupled with unsanitary conditions (Keiding, 1986). Regardless, environmental sanitation is one of the fundamental measures of fly control, under such situations, chemical control is indispensable (Rozandaal, 1997). Although many chemicals have been used to combat pest populations, unfortunately the hope of eradicating public health pests dissipated as several species developed resistance to certain of these chemicals within a relatively short period (Kaufman et al., 2001). Organophosphorous (OP) compounds have received major attention to over come resistance to chlorinated hydrocarbon compounds. Several organophosphorous compounds with moderate toxicity e.g., diazinon, fenchlorphos, malathion, fenthion, dimethoate and trichlorfon are used in fly control (WHO, 1997). However, insecticide resistance in house flies has been shown by a number of surveys and found to be wide spreading and increasing (Scott et al., 2000; Kaufman et al., 2001; Kristensen et al., 2001). In tsunami-hit coastal villages of Tamil Nadu and Pondicherry Union Territory (UT) in southern India,

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fly congregation was noticed, in temporary shelters and centralized kitchen, causing enormous stress to the afflicted victims. Since prolonged mass settlement of affected people at temporary shelters with a minimum provision of hygiene coupled with inadequate solid disposal measures might augment the spread of infectious diseases, fly control measures employing spraying of dichlorvos 76% Emulsifiable Concentrate (EC), an organophosphorous compound was carried out by the Directorate of Public Health (DPH), Government of Tamil Nadu, southern India. Despite the control measures, fly annoyance continued to be a major problem in the affected villages. Therefore susceptibility of *M. domestica* in the tsunami-affected coastal villages to dichlorvos was determined and the result is discussed in this communication.

## 2. Materials and methods

The natural disaster, tsunami, which affected several coastal villages of Tamil Nadu and Pondicherry Union Territory in southern India, during the end of the year 2004, had killed over 10,000 people. The Vector Control Research Centre (Indian Council of Medical Research), Pondicherry carried out a study to assess the abundance of muscoid flies and risk of fly-borne diseases in these areas during post-tsunami and described the condition (Srinivasan et al., 2006).

Environmental sanitation measures such as garbage removal and other solid waste disposal were undertaken by the DPH to reduce the fly menace. They also organized health camps for treating the affected victims. Apart from these measures, spraying of dichlorvos (76% EC), a commercial formulation with a trade name DASH manufactured by M/s Nagarjuna Agrichem Limited, Nagarjuna Hills, Punjagutta, Hyderabad, Andra Pradesh, India, at the concentration of 304 g (a.i.)/10,000 $m^2$ was carried out using hand operated sprayer, once a week initially for 2 months and once a fortnight subsequently, for quick elimination of fly concentrations in the affected villages.

Five tsunami-hit coastal villages viz., Akkaraipettai, Keechankuppam, Thirumullaivasal, Vizhundhamavadi and Pattinacherry, which were under constant spray operation with dichlorvos, were selected for fly collection. Each village is located 1–2 km way from others and 5–7 km form inland villages. Though spraying of dichlorvos was carried out in tsunami-hit areas as soon the disaster took place, no regular chemical control measure is being carried out in inland areas. House flies were collected from different habitats such as temporary shelters, centralized relief kitchens, devastated human settlements and open defecation yards, in each of the villages, using a sweep net during the 4th week of December 2005, 12 month after tsunami. Resting adult flies were collected between 10.00 and 12.00 h and flies obtained in each of the villages were held separately in one cubic foot cloth cages and brought to the laboratory. Females were confined for oviposition. The larvae hatched were reared on a mixture of milk and minced country filter paper and $F^1$ progenies were raised from the healthy females and used for laboratory bioassay (WHO, 1986, 2005). Susceptibility of flies to dichlorvos was determined through topical application (Kristensen et al., 2001). The test was conducted on 5 days old female flies with ≥similar size, which were maintained under controlled temperature (28 ± 2 °C) and relative humidity (60–75%), before and after topical application. Flies were provided with water, sugar solution and milk powder soaked in cotton wool, daily for feeding, from emergence, until all testing were completed. Prior to topical application, the flies were anaesthetized using a few drops of diethyl ether. One microlitre (1 μl) of dichlorvos (76% EC) containing the required quantity of active ingredient in microgram (μg), diluted with ethyl alcohol was applied on the dorsal side of thorax of house flies using a micropipette with the aid of a binocular dissection microscope. The flies were transferred into cloth cages. Mortality, the number of house flies dead i.e., which remained motionless or paralyzed i.e., lack of voluntary movement either by nerve or muscle dysfunction, was recorded at 24 h post treatment.

Parallel controls of house flies, collected from tsunami-hit villages treated with ethyl alcohol were maintained for comparison. Similarly, house fly progenies raised from wild caught female flies obtained from a rural area viz., Thirukanur, located 100 km away from tsunami-affected villages on their western side and hither to unexposed to chemicals of any type for fly control collected during the last week of December 2005 were also tested against dichlorvos, to know their tolerance and compared with that the flies collected from tsunami-hit areas.

The test was carried out at different dosages such as 0.1, 0.2, 0.4, 0.6 and 0.8 μg active ingredient (a.i.) per fly. Each concentration was tested with four replicates and 40 flies were used in each replicate for every village under study. The observed mortality was corrected to the control mortality if any, using the formula of Abbott (1925). The lethal dosage 50% and 90% ($LD_{50}$ and $LD_{90}$) were calculated using a computer software viz., Statistical Package for Social Science (SPSS), version 13.0.

## 3. Results

Mortality of house flies treated topically at different concentrations of dichlorvos (76% EC) varied between 17.5% and 100% and increased with an increase in dosage of the insecticide.

Mortality was >80%, when the flies were treated at 0.6 and 0.8 μg (a. i.)/fly. The $LD_{50}$ of dichlorvos (76% EC) tested against flies collected from different villages varied from 0.2041 μg (a.i.)/fly to 0.2456 μg (a.i.)/fly and the $LD_{90}$ varied from 0.5923 μg (a.i.) to 0.6426 μg (a.i.)/fly (Table 1). House flies of check area viz., Thirukanur when exposed to dichlorvos, the mortality was >90% at the concentration 0.2 μg (a.i.)/fly and increased to 100% thereafter, with a range from 92.5 to 100.0%. The $LD_{50}$ was 0.0399 μg (a.i.)/fly, while the $LD_{90}$ was 0.1604 μg (a.i.)/fly.

The Chi-square values ($\chi^2 < 14.0$) of the probit analysis of both the batches indicated that the fly populations obtained for testing from the tsunami-hit and check village were homogenous in terms of their response to the insecticide tested. Hence, fly population of the tsunami-affected villages showed a more or less same tolerance level to the insecticide, as villages are located adjacent to each other. However, the flies of check villages were