# PYRETHROID IMPREGNATED MOSQUITO NETS

## Protection from Mosquitoes and Malaria


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Malaria control becomes nearly impossible in certain areas. Such situations are usually caused by the following factors occurring singly or in combination:

- High rainfall with water logging
- Innumerable mosquito breeding sites with enormous surface areas
- High vector densities and continuous man-vector contact
- Areas refractory to spraying
- Tribal dominated, backward areas, forested and difficult terrain.

Rivers, streams, seepages, high water table, non-cooperative communities and poor health/communication facilities further exacerbate the problem. In such situations malaria control could be achieved by certain personal protection methods. One of the most successful method is the use of mosquito nets (bednets).

## IMPREGNATED MOSQUITO NETS

Since time immemorial mosquito nets have been used for protection from mosquitoes, malaria and nuisance insects. However, they do not provide sufficient protection because hungry mosquitoes may rest on the mosquito net and bite on the first available opportunity. This could either be due to damaged or improper tucking of mosquito net. Mosquitoes may bite when trapped inside the mosquito net. Those

outside may also bite, if any part of the body comes in contact with the mosquito net. There are some studies indicating nets being a favourable site for female mosquitoes to rest.

Attempts to treat mosquito nets with repellents to ward off mosquitoes failed. However, treatment (impregnation) of mosquito nets with synthetic pyrethroid with residual action removes the problem of plain mosquito nets and these are ideally suited to prevent man-mosquito contact.

## PYRETHROIDS

Pyrethroids are synthetic analogues of natural pyrethrins derived from the plant *Chrysanthemum cinerariifolium.* These include permethrin, cyfluthrin, deltamethrin, lambdacyhalothrin etc. Pyrethroids suitable for impregnating mosquito nets are available as emulsifiable concentrates (EC), oil-in-water emulsion (EW) and flow. Impregnation with wettable powder (WP) formulation is not accepted by the users due to flaking of powder during regular use.

## PROPERTIES OF PYRETHROIDS

- Cause fast knock down of mosquitoes on contact.
- Effective at low dosage on mosquito nets compared to conventional insecticides.
- Have long residual action (single impregnation lasts for more than 6 months if the mosquito net is not washed).

- Have low mammalian toxicity; absorption by skin is very poor.
- Are odourless and do not stain clothing.
- Have broad spectrum activity on headlice, cockroaches, bedbugs, ants etc.
- Easy to make emulsion of EC or EW formulation with water for impregnation. Flowable formulation mixes well with water.

## MOSQUITO NET SPECIFICATION

Mosquito nets of varying colour made of nylon or cotton fibre are suitable. Mosquito nets should be large enough to cover a bed properly. For a single bed mosquito net of 10 $m^2$ and for a double bed of 15 $m^2$ would be appropriate. Approximately, 10-15 cm cotton cloth should be properly hemmed with the net for tucking under the mattress or bed. Rectangular mosquito nets are generally preferred in India, however, mosquito nets of any other shape could also be used.

For proper ventilation mesh size of about 3 to 4 mm (i.e., 6-8 holes per linear inch or 3-4 holes per linear cm) is recommended.

## IMPREGNATION PROCEDURE

Impregnation of mosquito net with pyrethroid is achieved in three steps. They are:

### Step 1

The surface area of the net (Fig. 1) is determined by

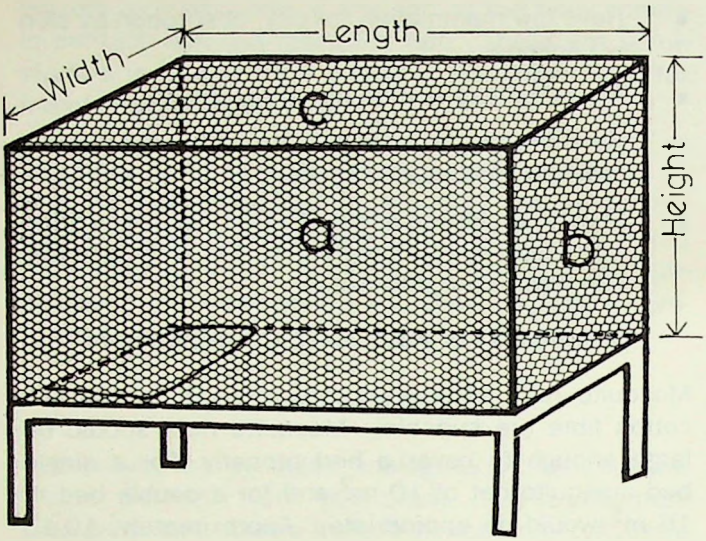


*Fig.1*: Surface area of an appropriate mosquito net S.A.= (a+b)+c

using the following formula:

Surface area = 2 (a+b)+c

Where, a = length x height

b = height x width

c = length x width

The amount of formulation of insecticide required for target dose of 25 mg/$m^2$ is calculated as:

Weight required (gm) = Surface area in $m^2$ x 0.025

The volume of formulation required is determined by:

$$\text{Volume required} = \frac{\text{Weight (gm)} \times 100}{\text{Per cent formulation of insecticide (ml)}}$$

For example, to impregnate a mosquito net of 10 $m^2$ using 2.5% EC formulation the volume of formulation required would be:

$$\frac{(10 \times 0.025) \times 100}{2.5} = 10 \text{ ml}$$

Once the volume of insecticide required for one mosquito net is standardized, the volume of water just sufficient for completely soaking the mosquito net without any dripping is determined by trial and error. Approximately a nylon mosquito net of 10 $m^2$ takes about 350 ml water. Always use cold water for impregnation.

### Step 2

The insecticide formulation and water (as per volumes determined) are mixed thoroughly in a wide plastic basin. Hand gloves should be used, while handling pyrethroid. The insecticide emulsion is applied thoroughly to the mosquito net by repeated rubbing and squeezing to distribute the emulsion evenly to all parts of the net. Netting part should be soaked first, followed by cotton hem.

### Step 3

The mosquito nets thus impregnated with insecticide are spread on a non-absorbent surface (such as a

plastic groundsheet) and allowed to become semi-dry. Semi-dry mosquito nets are then hung on a wire and allowed to dry completely. Mosquito nets could also be dried on cots or leaf mats. Both stages of drying should be accomplished in shade. One impregnation will last for more than six months, if the mosquito net is not washed. If washed before 6 months, reimpregnation is advisable for better results.

**Recommended dosages for Impregnation**

| Concentration of formulation | Net size (sq m) | Target dose (mg/sq m) | Volume of formulation (ml) |
|---|---|---|---|
| 2.5% | 10 | 25 | 10 |
| | 15 | 25 | 15 |
| 5% | 10 | 25 | 5 |
| | 15 | 25 | 7.5 |
| | 10 | 50 | 10 |
| | 15 | 50 | 15 |

## PRECAUTIONS

After impregnation hands and face should be washed thoroughly with soap and water. In some cases contact with emulsion during impregnation may result in transient mucosal irritation. Recommendations on container labels or sachets, if any, must be adhered to. Use of hand gloves is essential during impregnation. In case of non-availability of gloves, polythene bags could also be used.

## RESULTS OF BEDNET TRIALS

### Assam

The impact of mosquito nets treated with deltamethrin @ 25 mg/$m^2$, untreated nets and no nets (control) is shown in Fig. 2. Results clearly show that treated nets were very effective in malaria control. Untreated nets provided partial protection and there was no protection in areas without mosquito nets.

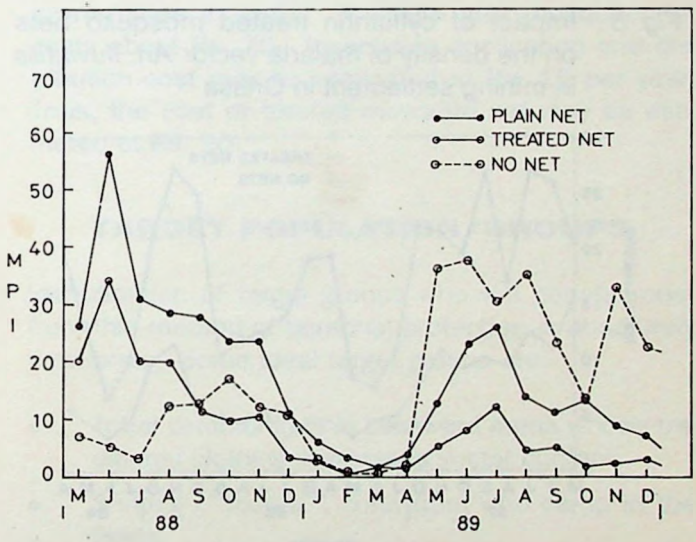


*Fig. 2*: Impact of deltamethrin treated mosquito nets on malaria incidence in Sonapur PHC, Assam

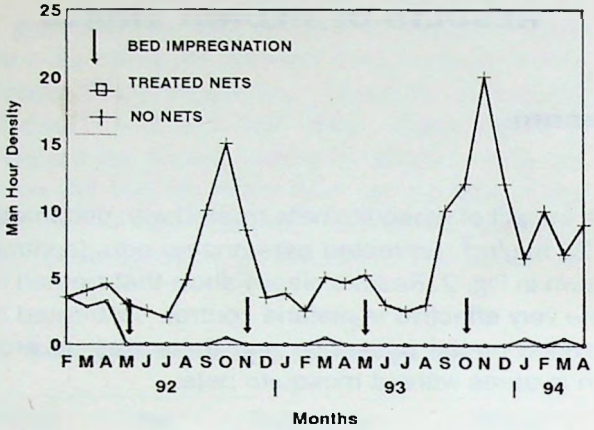


*Fig. 3 :* Impact of cyfluthrin treated mosquito nets on the density of malaria vector *An. fluviatilis* in mining settlement in Orissa

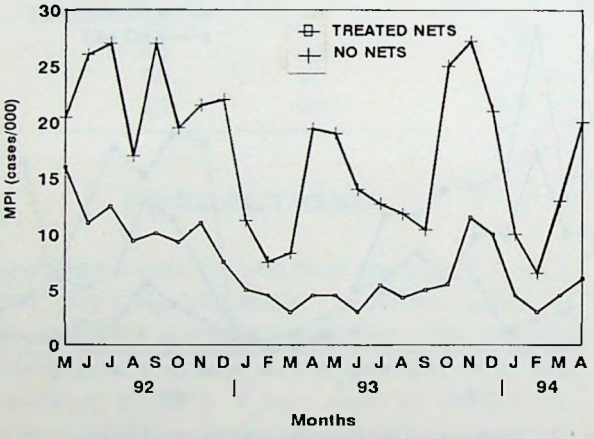


*Fig.4 :* Impact of cyfluthrin treated mosquito nets on malaria incidence in the mining settlements in Orissa

### Orissa

In the settlements of iron ore mines in District Sundargarh, Orissa introduction of mosquito nets impregnated with cyfluthrin @ 50 mg/$m^2$ led to significant decline in the density of malaria vector *Anopheles fluviatilis* (Fig. 3) and malaria incidence (Fig. 4).

## ECONOMIC CONSIDERATIONS

**Cost and availability of pyrethroids:** Nylon mosquito nets are easily available in most of the towns/cities in India. A single size mosquito net costs about Rs. 75. Insecticide application and distribution cost may be estimated at Rs. 15 per year. Thus, the cost of treated mosquito net may be estimated at Rs. 90.

## TARGET POPULATION/GROUPS

Identification of target groups who will benefit most from this method of personal protection is absolutely necessary. Some ideal target groups are:

- Tribal communities in backward areas whose traditional clothing maximises vector contact.
- Shifting ("Jhoom") cultivators who camp in the fields.
- Areas with high malaria vector density and continuous man-vector contact and where indoor spraying is not effective.

- Problem areas which have extensive breeding sites/resistant vector/drug resistant malignant malaria.
- Inaccessible areas such as hills/forest with poor communication facilities.
- Highly vulnerable groups namely pregnant women, infants, migrants from non-malarious areas to malarious areas (e.g. tourists), labour congregations, industries, mines, army installation etc. in forest.

## FIELD EXTENSION AND EDUCATIONAL SUPPORT

Better compliance with mosquito net usage at community level would increase their effectiveness. This can be achieved by education/extension activities along with distribution of mosquito nets. Users/ target groups should be prepared to accept mosquito nets as a way of life. The main discussion points with regard to use of mosquito nets are:

- Always sleep under a mosquito net.
- Make sure that all members of the family, especially children and expectant mothers, sleep under the net.
- Tie the net properly, preferably with cane poles or with strings on walls. If the net is properly stretched air flow is maintained and the user is more comfortable.
- Tuck the net properly under the mattress or bed from all sides.

- Use a larger net to avoid contact of exposed body parts with the net.
- Take good care of your net. If it gets torn, mend it carefully so that no holes are left.
- The pyrethroid is effective for more than 6 months, but washing removes it. Therefore, avoid washing as far as possible. If washing is inevitable treat the net again.

Educating communities is very important for the successful introduction of mosquito nets in any area. But once introduced they are habit forming and repeated persuasion is not required. Group meetings, video shows, lectures in local schools, colleges and door-to-door contact programme will enhance communication with the people and ensure community participation.

## ADVANTAGES

Mosquito nets are cost-effective, socially acceptable, free from health hazards and offer simple solution to an intractable problem. Impregantion with pyrethroid ensures greater effectiveness because of rapid knock down of all insects that come in contact. Since impregnation is long lasting and socially acceptable their effectiveness is ensured.

The method is environment-friendly as it obviates unproductive spraying. Since man-vector contact is greatest indoors, during night mosquito nets are a situation-specific remedy for the same.

A nylon mosquito net lasts for five to seven years. The recurring cost of insecticide impregnation is about Rs. 7-10. So, protection against mosquitoes is provided for Rs. 15-20 per annum. This is almost negligible when compared to the cost of repellents.

Thus the use of impregnated mosquito nets for malaria control is highly cost-effective, socially acceptable, sustainable and free from health hazards.

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