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Responses of *Anopheles balabacensis* to Various Patterns of DDT-spraying of Shelters in Sabah, East Malaysia

F. Y. CHENG [1]

In certain areas of Sabah, East Malaysia, local houses are frequently built without walls or with incomplete walls. Also, the people in these areas often refuse permission for their houses to be sprayed inside with insecticide (DDT). These special conditions are the reason for the persistence of malaria transmission under a WHO malaria eradication programme.

Field trials were conducted in specially constructed huts, similar to the local houses, in which all-night collections of mosquitos were made, both those biting human baits and those resting on walls, in order to determine (1) the effectiveness of spraying DDT in houses without, or with incomplete, walls; and (2) the best way to protect people against mosquito bites with DDT-spraying where the house-owners have refused indoor spraying.

The results indicate that (1) as expected, DDT-spraying inside a hut with incomplete walls is less effective than in a hut with complete walls, especially 6 months or more after spraying; (2) external spraying of walls with DDT at double the normal dose (i.e., 4 g/m²) greatly reduced contacts between man and mosquito and thereby limited transmission of malaria.

Attempts made in the course of a WHO Malaria Eradication Programme to interrupt malaria transmission in certain parts of Sabah, East Malaysia, with DDT treatments were not successful. A study of possible reasons for the failure of these efforts was made and it was found that, in addition to operational weaknesses due to insufficient or incomplete spraying of DDT, special conditions exist where houses are built without walls or with incomplete walls. No evidence was found of resistance to DDT in *Anopheles balabacensis*, the main vector of malaria in Sabah (McArthur, 1947). The habit of this species of resting on eaves, posts and upper walls outside houses before feeding and on the low overhangs of the thatch roofs after feeding was reported by Eyles et al. (1964) in Cambodia and by Scanlon & Sandhinand (1965) in Thailand, and it has also been investigated in Sabah by Cheng (unpublished data).

Accordingly, field trials were designed in order to find, first, the extent of the effect of DDT-spraying in structures with complete, or with incomplete, walls; and second, a means of protecting people against mosquito bites in houses whose owners refuse indoor spraying.

The procedure described below was evolved to investigate the first problem. To study the second, it was decided to extend an earlier suggestion to spray the "ingress surfaces" with insecticide (de Zulueta & Cullen, 1963) and to spray most of the outside surfaces with DDT. By this means it was hoped to secure a reduction of *Anopheles*-man contact and in this way to bring about a reduction in malaria transmission.

MATERIAL AND METHODS

The village of Lingan, in western Sabah, was selected for the investigations. It is an isolated village in the foothills about 12 miles (20 km) southwest from Papar town. The rainfall for 1966 in Papar was 104.31 inches (264.9 cm) and the mean relative humidity was around 83%. The rainfall was substantial in every month except January and February.

[1] WHO Entomologist, Malaria Eradication Programme, Sabah, East Malaysia.

In order to provide conditions similar to those normally encountered locally, 4 huts were built with split-bamboo walls, atap roof and bamboo floor; the floor was fixed 3 feet (90 cm) above the ground. The dimensions of the hut were 15 ft by 10 ft (4.6 m by 3 m) with the walls 8 feet (2.4 m) high and a 6-inch (15-cm) opening between eaves and walls. The apex of the roof was about 13 feet (4 m) above floor-level. The other openings in the huts were the entrance, closed by a door,[1] on the south wall and a small window opening, measuring 12 by 18 inches (30 by 45 cm) on each of the other walls. The huts were constructed with detachable walls so that they could be put up or taken down easily. The huts were erected 50 feet (15.3 m) apart. One of them was left unsprayed as control; the others were used to test various systems of spraying.

On the rural structures in Sabah, built with split bamboo, window traps have not proved successful in trapping mosquitos, which rarely entered the traps since they had many alternative ways for getting in and out of the houses. In these trials, therefore, mosquitos were collected when biting or when resting on the walls. Throughout the night when collections were being made each hut contained two resting men as bait and one experienced collector to catch the mosquitos biting himself and the other baits. The collectors worked a 6-hour shift, one team from 1800 hours to midnight and another team from midnight to 0600 hours. While there was no planned rotation of men between the different huts (Garrett-Jones),[2] the men changed hut frequently, serving either as baits or as collectors. Two supervisors, stationed in Lingan, worked alternately to check the work of the collectors.

While observations continued for the 12-hour period, the two human baits lay down on the floor, with bare arms and legs, and the collector sat between them. The light was put out and the door was kept closed, but the window openings were not covered. All mosquitos biting the three baits, or found resting on walls and on the accessible part of the roof, were collected. Thus the index of mosquitos caught biting per hut would represent 3 times the indoor component of the man-biting rate as defined by Garrett-Jones (*op. cit.*). The last quarter of each hour was given to collecting mosquitos at rest. For each mosquito, the aspect of the resting wall (east, north, west or south) was noted, also the abdominal condition of the mosquito. A 24-hour survival test was performed on all the mosquitos captured alive.

The investigations were carried out in 3 successive steps. An initial period (4–13 January 1966) was devoted to studying the behaviour of *A. balabacensis* in incomplete, unsprayed huts in order to assess its response to the physical obstacle presented by the progressive building-up of walls. These conditions duplicate those found in Sabah in the Sugut River Basin.

From 14 January to 10 February, all 4 huts were provided with complete walls and 3 of the huts were sprayed with DDT at different dosages and different degrees of coverage. These treatments are detailed in Table 1. Where the experiment demanded it, walls sprayed on one side were discarded later, to be replaced by walls differently sprayed.[3] The gabled roofs remained unsprayed at all times.

The third step was carried out during the periods 29 March–19 April, 10 May–3 June, and 15 August–3 September, using the 4 huts as they were at the end of step 2 (i.e., on 10 February). The purpose was to assess the residual effects of the DDT on *A. balabacensis*.

RESULTS

The results of the observations before and soon after treatment are shown in Tables 2–5. The observations at 3 periods later in the year are summarized in Table 6.

Pre-spray collections

Prior to the DDT-spraying only limited sampling was possible, as seen in Table 2. But with due reserve it may be noted that the complete, 4-walled huts attracted fewer biting and fewer resting mosquitos per night than any of the incomplete huts (except perhaps the hut with a single wall). The incidence of biting was greatest in the hut with no walls, while the resting density was highest in the hut with three walls. It may be supposed that this latter hut offered the resting mosquitos an optimal combination of easy access and adequate shelter.

As to the preferred aspect of the resting site, the table shows that the south wall attracted most

[1] The door was constructed of split-bamboo.

[2] Garrett-Jones, C. (1964) *A method for estimating the man-biting rate* (unpublished working document WHO/Mal/450). A limited number of copies of this document are available to persons officially or professionally interested on request to Distribution and Sales, World Health Organization, 1211 Geneva, Switzerland.

[3] It should be noted that in Table 1, and the subsequent tables, the hut numbers are preceded by a letter designating the stage of the experiment. Thus hut 3 is variously shown as A3, B3, C3, etc.

TABLE 1

SUCCESSIVE STEPS IN CONSTRUCTING AND SPRAYING THE 4 EXPERIMENTAL HUTS

Date	Hut No. and stage	No. of walls fitted	No. of walls sprayed with DDT [a]		Eaves sprayed with DDT [a]	Under-floor sprayed with DDT [a]
			Inside	Outside [b]		
4 Jan.	A1	1	—	—	—	—
	A2	2	—	—	—	—
	A3	3	—	—	—	—
	A4	0	—	—	—	—
6 Jan.	B1	4	—	—	—	—
	B2	4	—	—	—	—
	B3	4	—	—	—	—
	B4	0	—	—	—	—
14 Jan.	C1	4	0	0	0	0
	C2	4	1	0	0	0
	C3	4	2	0	0	0
	C4	4	3	0	0	0
18 Janv.	D1	4	0	0	0	0
	D2	4	0	1	0	0
	D3	4	0	2	0	0
	D4	4	0	3	0	0
26 Jan.	E1	4	0	0	0	0
	E2	4	4	0	4	1
	E3 [c]	4	0	0	4	0
	E4	4	3	0	4	1
10 Feb.	F1	4	0	0	0	0
	F2	4	4	0	4	1
	F3 [c]	4	0	4	4	1
	F4	3	3	0	3	1

[a] Spraying was with 2 g/m² DDT except where otherwise stated.
[b] Where outsides of walls were sprayed, the DDT was applied to the upper halves only.
[c] Sprayed with 4 g/m² DDT.

mosquitos when there were 3 or 4 walls to choose from. Easily the least attractive surface was the roof, despite the shelter afforded by its closed gable. There, a high resting density was found only in the hut without any walls.

The results also indicate that *A. balabacensis* showed high levels of activity between 21.00 and 24.00 hours and between 24.00 and 03.00 hours. The activity was less, though still substantial, in the first and the fourth quarters of the night.

Collections in huts variously and recently treated with DDT

Table 3 shows that the indoor resting density dropped to a low level after the *internal* spraying of

TABLE 2

INDOOR DENSITY OF *A. BALABACENSIS* IN DIFFERENT HUTS, BEFORE SPRAYING (4–13 JANUARY 1966)

Hut No. and stage	No. of walls erected	No. of mosquitos caught biting	No. of mosquitos caught at rest at different sites		Total catch (biting and resting) each quarter of night [a]		No. of nights worked	No. of mosquitos per night per hut	
								Biting	At rest
A4 + B4	None	265	Roof [b]	157	1st	88	8	33	20
			Total	157	2nd	135			
					3rd	136			
					4th	63			
					Total	422			
A1	1 (south)	18	South wall	27	1st	10	2	9	14
			Roof [b]	1	2nd	19			
			Total	28	3rd	13			
					4th	4			
					Total	46			
A2	2 (south, east)	50	South wall	7	1st	16	2	25	20
			East wall	18	2nd	28			
			Roof [b]	14	3rd	27			
			Total	39	4th	18			
					Total	89			
A3	3 (south, east, west)	50	South wall	35	1st	20	2	25	28
			East wall	18	2nd	33			
			West wall	3	3rd	38			
			Roof [b]	0	4th	15			
			Total	56	Total	106			
B1 + B2 + B3	4	176	South wall	81	1st	52	18	10	11
			East wall	38	2nd	135			
			West wall	44	3rd	111			
			North wall	33	4th	78			
			Roof [b]	4	Total	376			
			Total	200					

[a] First quarter, 18.00–21.00 hours; second quarter, 21.00–24.00 hours; third quarter, 24.00–03.00 hours; fourth quarter, 03.00–06.00 hours.

[b] Roof with closed gable.

even one wall only. However, the incidence of biting was not reduced until at least 2 walls were sprayed. After partial *external* spraying on 18 January (Table 4) the mosquito densities also dropped in all instances. The more walls sprayed, the fewer the mosquitos collected. But it is noteworthy that the indoor resting density (although the internal surfaces were unsprayed) decreased more sharply than the incidence of biting.

A comparison of Tables 3 and 4 indicates that in huts with complete walls, a similar initial reduction in the indoor densities of *A. balabacensis* may be obtained by spraying either the inside or the outside surfaces.

TABLE 3

INDOOR DENSITIES OF *A. BALABACENSIS* IN COMPLETE HUTS ON 14 AND 17 JANUARY, AFTER PARTIAL INDOOR SPRAYING [a] ON 14 JANUARY

Hut No. and stage	Spray status of hut	No. of mosquitos caught biting	No. of mosquitos caught at rest [b]	No. of mosquitos on each wall [c]	Total catch (biting and resting) each quarter of night [d]	Catch per night per hut		24-hour over-all mortality	
						Biting	At rest	No. [e]	%
C1	Unsprayed (control)	9	F 16 U 11 Total 27	South wall 10 East wall 6 West wall 2 North wall 9	1st 6 2nd 14 3rd 6 4th 10	4.5	13.5	0 (36)	0
C2	1 wall (south) sprayed	11	F 0 U 3 Total 3	East wall 1 North wall 2	1st 2 2nd 2 3rd 0 4th 10	5.5	1.5	3 (14)	21
C3	2 walls (south, west) sprayed	3	F 0 U 0 Total 0	—	1st 0 2nd 2 3rd 1 4th 0	1.5	0	0 (3)	0
C4	3 walls (south, west, east) sprayed	2	F 0 U 1 Total 1	East wall 1	1st 1 2nd 1 3rd 1 4th 0	1	0.5	0 (3)	0

[a] 2 g/m² DDT. [b] F = blood-fed; U = unfed. [c] Negative results omitted. [d] See Table 2 for periods. [e] Total sample in parentheses.

The results of 18 January–9 February (Table 5) show that the conventional spraying of a 4-walled hut reduced considerably the indoor density of *A. balabacensis* (E2); incomplete conventional spraying was less effective (however, this result conflicts rather sharply with the earlier findings in hut C4; see Table 3).

The different patterns of spraying that were substituted on 10 February (see Table 1) and evaluated on 11, 14 and 15 February, showed that a more complete external spraying with 4 g/m² DDT (hut F3) had the same effects as the conventional spraying with 2 g/m² DDT: the index of biting mosquitos was reduced in both huts to 1.3 (against 7.3 in the control), and that of resting mosquitos to 0 (against 14.3). Meanwhile, hut 4 was conventionally sprayed but had the north wall removed; this resulted in low but intermediate indices—2.3 per night caught biting, 0.7 caught at rest.

To sum up the results given in Tables 3–5, the observed resting densities were invariably higher than the numbers caught biting in the unsprayed controls, whereas in all the sprayed huts (irrespective of coverage and dosage) this position was reversed. Further, the 24-hour mortalities in the mosquitos collected in the treated huts were consistently below 50%, with the single exception of hut E4. For reasons that are obscure, that was the only hut in which substantial numbers of mosquitos were found at rest actually on the sprayed surfaces (Table 5).

Residual effects at intervals of several months after spraying

From Table 6 it is clear that all the spraying patterns tested still had some effect on indoor densities of mosquitos for at least 29 weeks after spraying. The over-all numbers of *A. balabacensis* caught in hut F2 (complete, and conventionally sprayed

TABLE 4

INDOOR DENSITIES OF *A. BALABACENSIS* IN COMPLETE HUTS ON 18, 19 AND 25 JANUARY AFTER PARTIAL SPRAYING [a] OF OUTSIDE SURFACES ON 18 JANUARY

Hut No. and stage	Spray status of hut	No. of mosquitos caught biting	No. of mosquitos caught at rest [b]	No. of mosquitos on each wall [c]	Total catch (biting and resting) each quarter of night [d]	Catch per night per hut		24-hour over-all mortality	
						Biting	At rest	No. [e]	%
D1	Unsprayed (control)	34	F 18 U 26 Total 44	South wall 10 East wall 8 West wall 15 North wall 11	1st 11 2nd 22 3rd 23 4th 22	11.3	14.7	0 (78)	0
D2	External: 1 wall (south sprayed	20	F 1 U 6 Total 7	South wall 3 North wall 4	1st 1 2nd 10 3rd 11 4th 5	6.7	2.3	5 (27)	19
D3	External: 2 walls (south, west) sprayed	6	F 2 U 2 Total 4	South wall 2 West wall 1 North wall 1	1st 2 2nd 5 3rd 2 4th 1	2.0	1.3	2 (10)	20
D4	External: 3 walls (south, west, east) sprayed	5	F 0 U 0 Total 0	—	1st 1 2nd 2 3rd 1 4th 1	1.7	0	0 (5)	0

[a] 2 g/m² DDT. [b] F = fed; U = unfed. [c] Negative results omitted. [d] See Table 2 for periods. [e] Total sample in parentheses.

except for the roof) were 17 times lower than in the control hut (F1) 47–68 days after spraying; 7 times lower 95–113 days after spraying; and 4 times lower 186–205 days after spraying. But the relative reductions in biting density were again consistently smaller than those in resting density, and by the third period the observed reduction in the biting index was only 57%.

The mortality rates in these mosquitos were 100%, 92% and 90%, respectively. These are high rates, considering that the major part of each sample was caught biting. They suggest that *A. balabacensis* experiences lethal contact with the insecticide before taking a blood-meal in a sprayed house having 4 walls; and that their longevity might be sufficiently reduced to prevent them from playing a role in maintaining transmission. It is not clear why a lower mortality was found in this hut (Table 5) when the DDT had been freshly applied.

The densities obtained in hut F3, treated externally with 4 g/m² DDT, appear to be similar to those reported for hut F2, although, as expected, the mortality rates were lower (40%, 58% and 50%, respectively). Indoor densities 186–205 days after spraying, however, were actually lower than in hut F2, presumably owing to the longer persistence of the higher dosage applied, externally.

Finally, in the hut fitted with only 3 walls and sprayed internally (F4), the biting and resting densities were higher than in hut F2 (except in the second period) but were nevertheless substantially reduced (by 6, 16 and 1.8 times, respectively) compared with the control. The mortalities in the small samples taken in F4 were 73%, 100% and 78%, respectively, in the successive evaluation periods. They may be considered favourable in the light of the observation that a hut of this construction (A3, Table 2) attracted the largest average numbers of resting *A. balabacensis*,

TABLE 5

INDOOR DENSITIES OF *A. BALABACENSIS* IN COMPLETE HUTS ON TEN NIGHTS BETWEEN 27 JANUARY AND 9 FEBRUARY, AFTER VARIOUS PATTERNS OF DDT-SPRAYING ON 26 JANUARY

Hut No. and stage	Spray status of hut	No. of mosquitos caught biting	No. of mosquitos caught at rest [a]	No. of mosquitos on each wall [b]	Total catch (biting and resting) each quarter of night [c]	Catch per night per hut		24-hour over-all mortality	
						Biting	At rest	No. [d]	%
E1	Unsprayed (control)	100	F 65 U 155 Total 200	South wall 66 East wall 62 West wall 47 North wall 45	1st 94 2nd 92 3rd 70 4th 64 Total 320	10.0	22.0	2 (320)	0.6
E2	DDT (2 g/m²) sprayed inside walls, on eaves, & under floor	16	F 1 U 0 Total 1	South wall 1	1st 3 2nd 6 3rd 5 4th 3 Total 17	1.6	0.1	7 (17)	41.2
E3	DDT (4 gm/m²) sprayed on eaves only	26	F 9 U 3 Total 12	South wall 3 East wall 3 West wall 3 North wall 3	1st 2 2nd 16 3rd 10 4th 10 Total 38	2.6	1.2	12 (38)	31.6
E4	DDT (2 gm/m²) sprayed inside 3 walls (south, east, west) on eaves, & under floor	42	F 26 U 7 Total 33	South wall 12 East wall 11 West wall 9 North wall 1	1st 14 2nd 23 3rd 20 4th 18 Total 75	4.2	3.3	56 (75)	74.7

[a] F = fed; U = unfed. [b] Negative results omitted. [c] See Table 2 for periods. [d] Total sample in parentheses.

before spraying. Nevertheless, some 6 months after spraying, the nightly rate of biting on the 3 baits in this hut reached 5.0—almost equal to the rate in the control hut.

DISCUSSION

The interpretation of the results described above is subject to some reservation since it was not feasible to exchange the baits in a regular manner between one hut and another. Subject to this caution, it appears that the presence of 4 untreated walls (Table 2) provided a fair degree of protection from biting by *A. balabacensis* and similarly reduced the number of resting mosquitos. On the other hand, the presence of only 3 walls or fewer probably had no consistent influence on the number of mosquitos, biting or resting, in comparison with a shelter consisting merely of a gabled roof supported on 4 poles.

Table 3 shows that substantial further protection was afforded initially when at least 2 walls (of a complete hut) were sprayed normally with DDT. Alternatively, the spraying of the *outside* on not less than 3 walls (Table 4) seemed to afford a similar degree of protection. Indeed, the indices in hut E2 (Table 5) indicate that the normal spraying of all 4 walls, together with the eaves and the underside of the floor, gave little if any extra protection.

These positive results are remarkable when we consider the fact that the mosquitos had ready means of entry and exit at all times *via* the eaves and the

TABLE 6

INDOOR BITING AND RESTING DENSITIES OF *A. BALABACENSIS* IN HUTS VARIOUSLY SPRAYED WITH DDT, AT INTERVALS UP TO 29 WEEKS AFTER TREATMENT

Hut No. and stage	No. of walls present	Spray status of hut (treatment of 10 February)	Evaluation-period I (15 nights worked) [a]			Evaluation-period II (15 nights worked) [a]			Evaluation-period III (17 nights worked) [a]		
			Catch per night per hut		24-hour over-all mortality (%) [b]	Catch per night per hut		24-hour over-all mortality (%) [b]	Catch per night per hut		24-hour over-all mortality (%) [b]
			Biting	At rest		Biting	At rest		Biting	At rest	
F1	4	Unsprayed (control)	8.4	14.6	0 (345)	12.3	18.8	0 (467)	5.8	7.7	0 (230)
F2	4	DDT (2 gm/m²) on insides of walls, eaves, and underfloor	0.8	0.5	100 (8)	2.3	2.0	92 (26)	2.5	0.7	90 (19)
F3	4	DDT (4 gm/m²) on outsides of walls (upper half), eaves and under floor	0.7	0.2	40 (5)	2.5	1.5	58 (24)	0.5	0.5	50 (8)
F4	3 (south, east, west)	DDT (2 gm/m²) on insides of walls, eaves and under floor	1.7	2.0	73 (11)	1.3	0.7	100 (6)	5.0	2.4	78 (37)

[a] In each period the " nights of observation " refer to the number of observations (1) in the control hut F1 and (2) distributed on an all-night basis between huts F2, F3 and F4. The intervals from spraying (i.e., from 10 February) were 47–68 days (period I), 95–113 days (period II) and 186–205 days (period III).

[b] Total sample (biting and resting) in parentheses.

windows. They suggest that further field trials would be warranted in Malaysia and in other countries on the effectiveness of " partial coverage " of buildings with DDT. Such a policy, if without prejudice to the technical progress of the attack, would make possible a major saving in its cost, as was demonstrated by Gramiccia, Garrett-Jones & Sultan (1953).

It is noteworthy that the spraying of 3 walls in hut E4 also produced a mortality in the first 2 weeks of about 75% of the over-all sample. Surprisingly, a room-kill of this order was apparently maintained for upwards of 6 months after the fourth wall of the hut was removed altogether (F4, Table 6). This was the only incomplete hut in which the effects of DDT were observed in this series of trials, and the result clearly suggests the need for further work of this kind.

Table 6 also shows that a complete hut whose walls were normally treated yielded persistently low densities of the vector and produced mortalities of 90% or over for at least 29 weeks after treatment. Again, the spraying of the outside surfaces of a similar hut (F3) with a double dosage of DDT reduced the biting and resting densities to a comparable degree through the first 2 evaluation periods (weeks 6–10, and 14–16). In the third period (weeks 26–29) the external residue of 4 g proved to be more persistent in its impact on indoor densities than the internal residue of 2 g, despite the weathering to which the external deposits must have been subjected. In all periods, however, the mortalities were significantly lower among those mosquitos that managed to pass the barrier of the walls sprayed externally.

CONCLUSIONS

From the data collected in these series of trials the following conclusions can be drawn tentatively:

(1) In a complete hut, *A. balabacensis* has shown a normal response to DDT-spraying of the walls at the usual dosage of 2 g/m². Its indoor density dropped immediately after DDT-spraying and remained at a low level for over 6 months. A majority of the mosquitos biting in this hut were found to have picked up a lethal dose of insecticide.

(2) DDT-spraying in a house with only 3 walls (hut F4) appears somewhat less effective, especially 6 months after the treatment.

(3) Although external spraying at a double dosage gave mortalities that would not offer complete protection against malaria transmission the indoor mosquito densities were significantly reduced in relation to the findings in the control hut and the conventionally sprayed hut. It appears that this method should reduce contact between vector and man, thus limiting transmission. This method of spraying could well be utilized as an additional measure in areas where conventional spraying is unpractical for any given reason. It deserves to be tested in the field on a larger scale.

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RÉSUMÉ

Dans certaines régions du Sabah, Malaisie orientale, on a constaté la persistance de la transmission du paludisme pendant l'exécution d'un programme d'éradication. Une des causes principales de cet échec est la difficulté d'obtenir une couverture totale par pulvérisations d'insecticides, les habitations locales étant dépourvues de murs ou non entièrement closes.

Une étude de la réaction d'*Anopheles balabacensis*, le principal vecteur, aux pulvérisations de DDT a été entreprise en 1966. On a installé des cases expérimentales, à parois amovibles, imitant le type des constructions locales et procédé à la capture nocturne des moustiques agressifs pour l'homme ou au repos sur les parois à l'intérieur des cases. En l'absence de traitement, on a recueilli davantage de moustiques dans les cases sans murs ou dans les cases à trois murs que dans les cases complètement closes. L'application de DDT à raison de 2 g/m² dans les cases à trois murs n'a pas donné de résultats pleinement satisfaisants; 6 mois après les pulvérisations, on dénombrait encore 7,4 moustiques par nuit et par local. Dans les cases à quatre murs, dont les parois, mais non le plafond, avaient été traitées intérieurement par le DDT à la concentration de 2 g/m², l'efficacité de l'insecticide a persisté pendant 6 mois, avec une réduction du taux d'agressivité de 50% et une mortalité globale atteignant 90%.

Après pulvérisations de DDT à la concentration de 4 g/m² sur la surface extérieure des cases à quatre murs, on a constaté dans les 6 mois suivant l'application une réduction notable du taux d'agressivité des moustiques, une chute de la densité anophélienne et une mortalité globale de 50%. Cette méthode paraît applicable, en tant que mesure complémentaire, dans les régions où, pour l'une ou l'autre raison, les pulvérisations classiques ne peuvent être effectuées.

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