Field Application of the Intensity Bottle Bioassay

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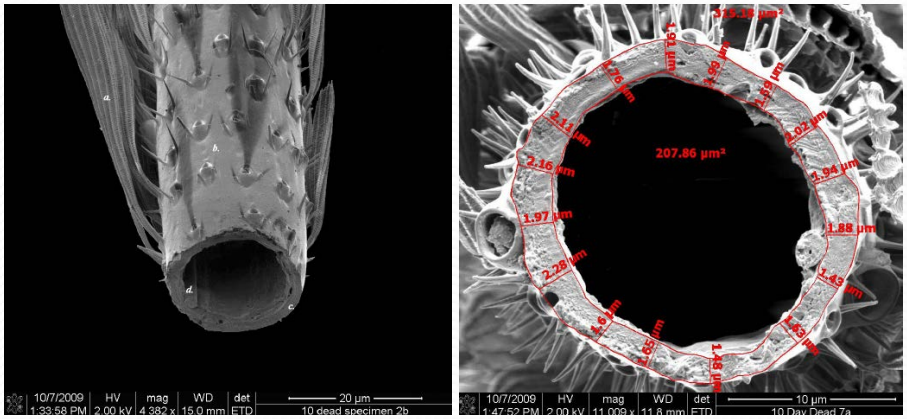
Insecticide resistance

- "a heritable change in the sensitivity of a pest population that is reflected in the repeated failure of a product to achieve the expected level of control when used according to the label recommendation for that pest species" - Insecticide Resistance Action Committee

- Contributed to failure of disease control programs
  - Global Malaria Eradication Programme (1955-1969)
  - Resistance of headlice to permethrin/organophosphates

Types of resistance

- Metabolic
  - Esterases
  - Oxidases
  - Glutathione S-transferases
- Target-site mutation
  - Sodium channel (kdr)
  - Acetylcholinesterase ($Ace1^R$)
  - GABA
- Other
  - Cuticular thickening
  - Behavior change



Wood et al. 2010, Parasites & Vectors

Resistance monitoring

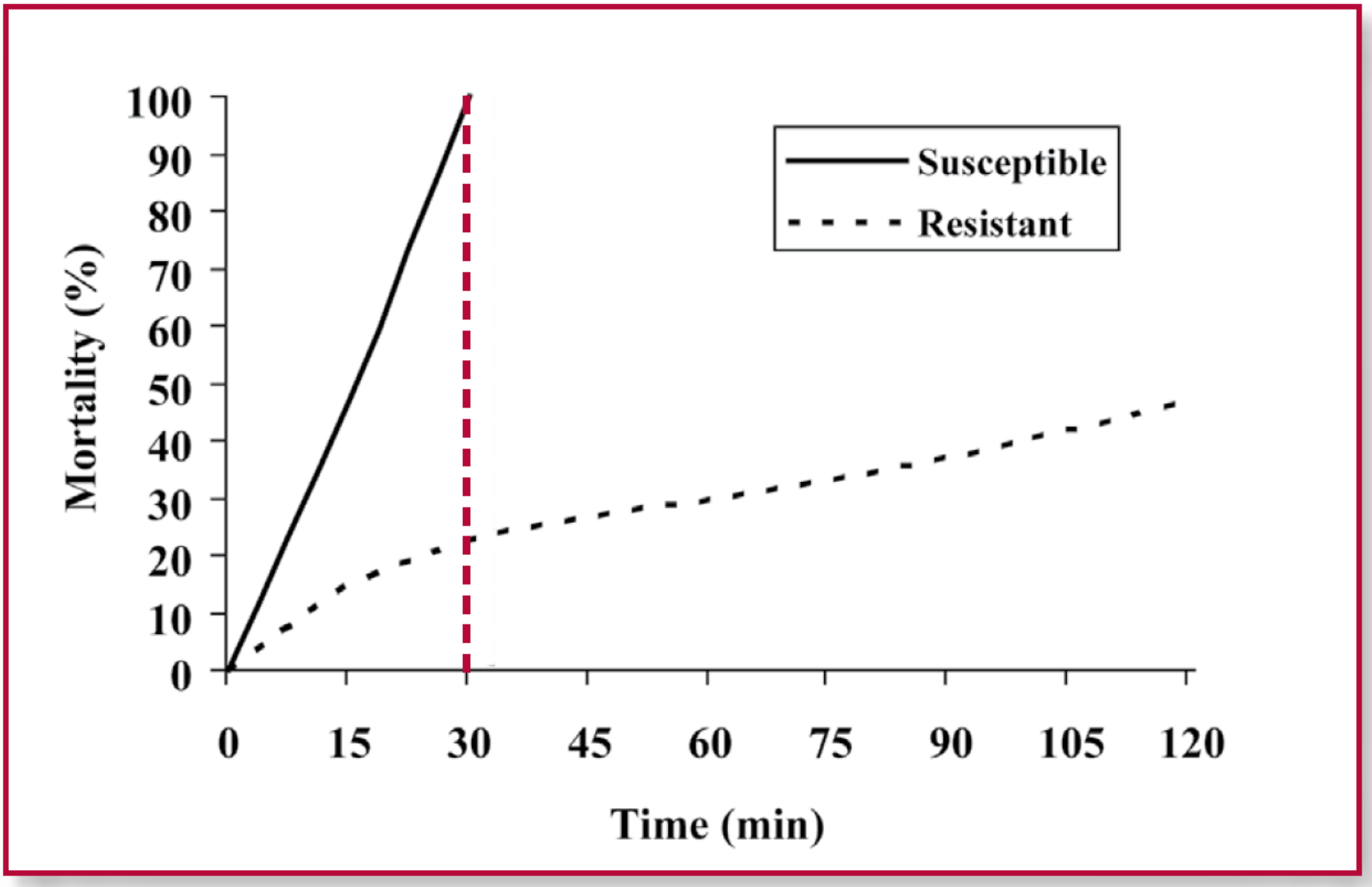
- Detection of resistance mechanisms (genotypic)
  - Genotyping (target site mutations)
  - Biochemical analysis (metabolic resistance)
  - Semi-field/field data (behavior change)

- Bioassays (phenotypic)
  - Larval bioassays
  - Topical application
  - Timed exposure (WHO cone test, Bottle bioassay)

Bottle bioassay

Diagnostic time

Table 1: Sample diagnostic doses and diagnostic times for *Anopheles* and *Aedes* mosquitoes.			
Insecticide	Insecticide concentration per species (µg/bottle)		Diagnostic time (minutes)
	Anopheles	*Aedes*	
Bendiocarb	12.5	12.5	30
Cyfluthrin	12.5	10	30
Cypermethrin	12.5	10	30
DDT	100	75	45
Deltamethrin	12.5	10	30
Fenitrothion	50	50	30
Lambdcyhalothrin	12.5	10	30
Malathion	50	50	30
Permethrin	21.5	15	30
Pirimiphos-methyl	20	—	30


Mortality (%)
100
90
80
70
60
50
40
30
20
10
0
0
15
30
45
60
75
90
105
120
Time (min)
Susceptible
Resistant

Synergists

- Piperonyl butoxide
  - Inhibits oxidase activity
- S.S.S-tributylphosphorotrithioate (DEF)
  - Inhibits esterase activity
- Ethnacrynic acid (EA), diethyl maleate (DM/DEM), and chlorfenethol (CF)
  - Inhibit glutathione S-transferase activity

Possible outcomes in bottle bioassays using synergists

Fig. 10a.

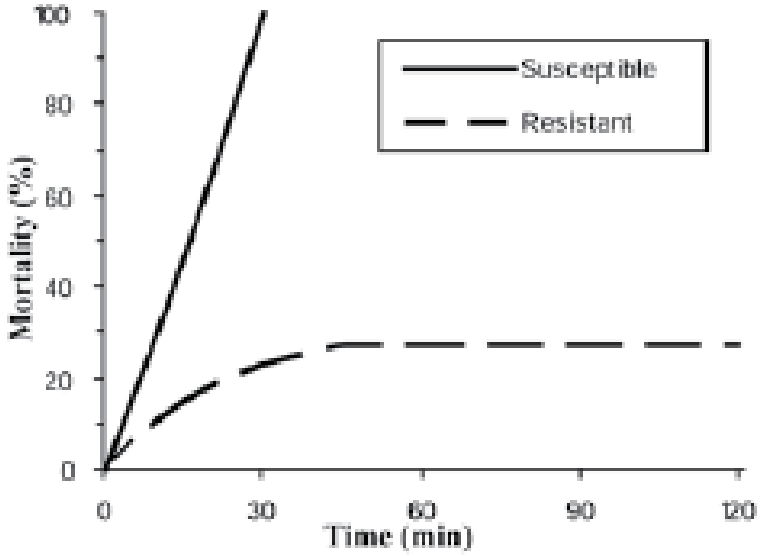
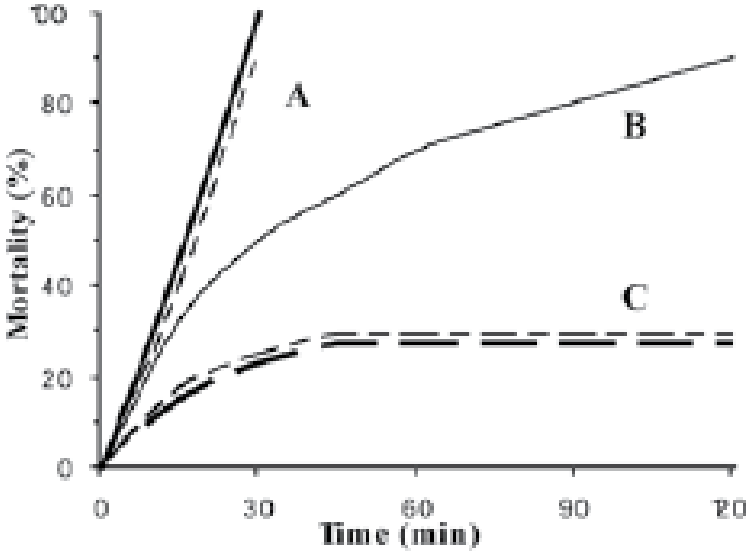


Fig. 10b.



Does resistance mean control failure?

- Sometimes

Medical and Veterinary Entomology (2000) **14**, 181–189

Impact of DDT re-introduction on malaria transmission in KwaZulu-Natal

R Maharaj, D J Mthembu, B L Sharp

Objectives. To determine whether the re-introduction of DDT in KwaZulu-Natal had any effects on malaria transmission in the province.

Outcome measures. The notified malaria cases and the distribution of *A. funestus* were measured to determine the effects of DDT re-introduction on malaria transmission.

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Does resistance mean control failure?

- Sometimes not

Am. J. Trop. Med. Hyg., 73(5), 2005, pp. 859–864

PROTECTIVE EFFICACY OF LAMBDA-CYHALOTHRIN TREATED NETS IN *ANOPHELES GAMBIAE* PYRETHROID RESISTANCE AREAS OF CÔTE D'IVOIRE

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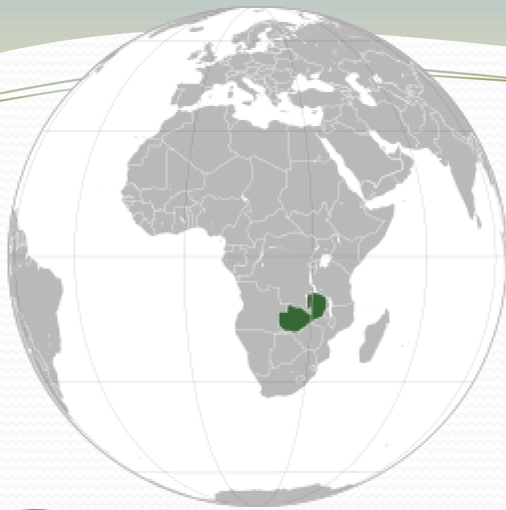
Abstract. The efficacy of nets treated with lambda-cyhalothrin, a pyrethroid insecticide, on malaria infection and disease was assessed for the first time at the community level in *Anopheles gambiae* pyrethroid resistance areas. The study was carried out in northern Côte d'Ivoire, which is an area of *kdr* resistance. Four pairs of villages were selected and matched according to demographic, sociological, and ecological criteria. Among each pair, a village was randomly allocated to receive mosquito nets. More than 80% of beds were covered with nets treated with lambda-cyhalothrin and retreated after 6 months. In each village, 54 children aged 0–59 months were randomly selected and clinically monitored for 8 periods of 7 days throughout the year. Results showed that the efficacy of treated nets was maintained with a reduction of the prevalence of asymptomatic malaria infection by 12% and an estimated protective efficacy against malaria disease of 56%.

How can we tell when resistance is having an effect?

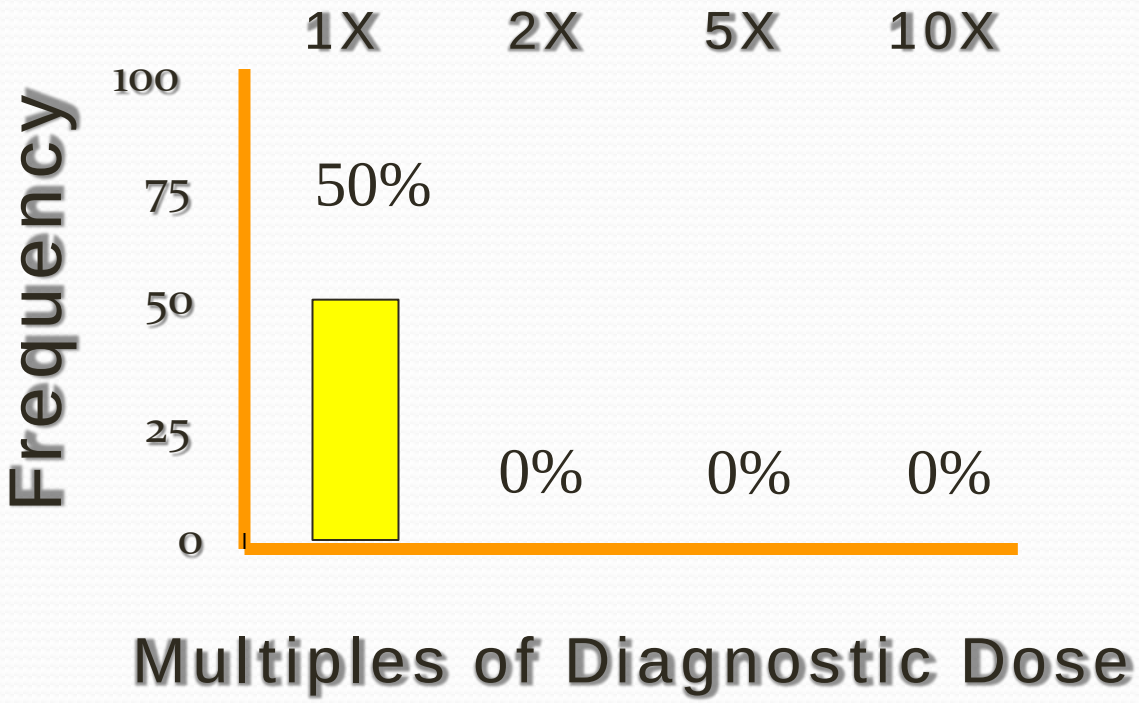
Intensity assay



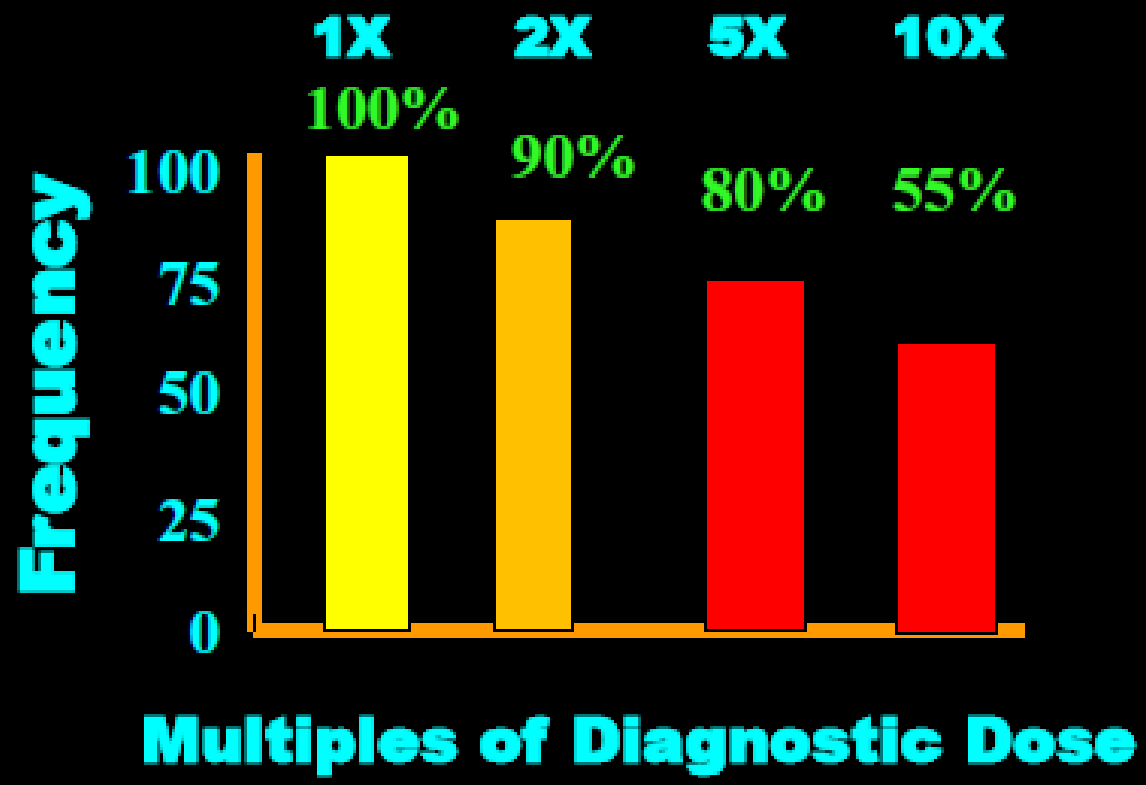

DEMOCRATIC REPUBLIC OF THE CONGO
Mweru
Mpulungu
Kasama
Mafinga Hills
Lake Bangweulu
Luapula
ANGOLA
Solwezi
Mufulira
Kitwe
Ndola
Kapiri Mposhi
Chipata
MAL.
Kabwe
Mongu
LUSAKA
Zambezi
Lake Kariba
Zambezi
MOZ.
NAMIBIA
Livingstone
ZIMBABWE
BOTSWANA
0 100 200 km
0 100 200 mi


Kansanshi
Lumata
Solwezi
T5
Kasumbalesa
Musoshi
Tshinsenda
T5
Semu
Chililabombwe
Mokambo
Chingola
T5
Mufulira
Chambishi
Kitwe
Sakania
Mapunga
M18
M18
T3
Ndola
Luanshya

Mushili, Ndola – *Anopheles gambiae* Deltamethrin

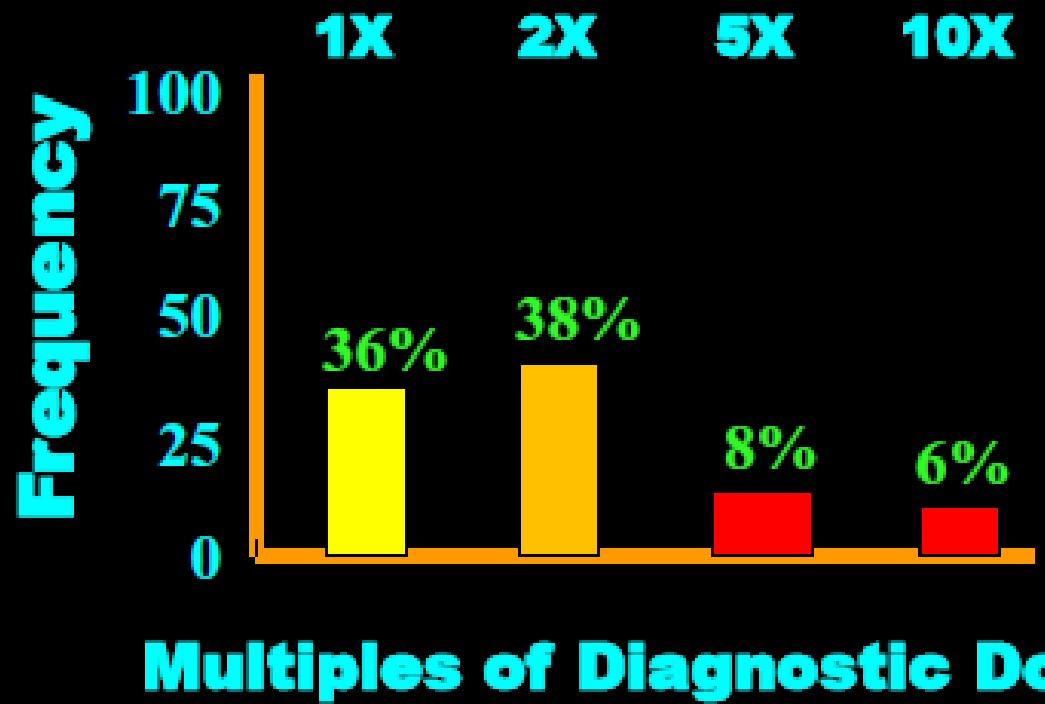


Mufulira – *Anopheles gambiae*
DDT

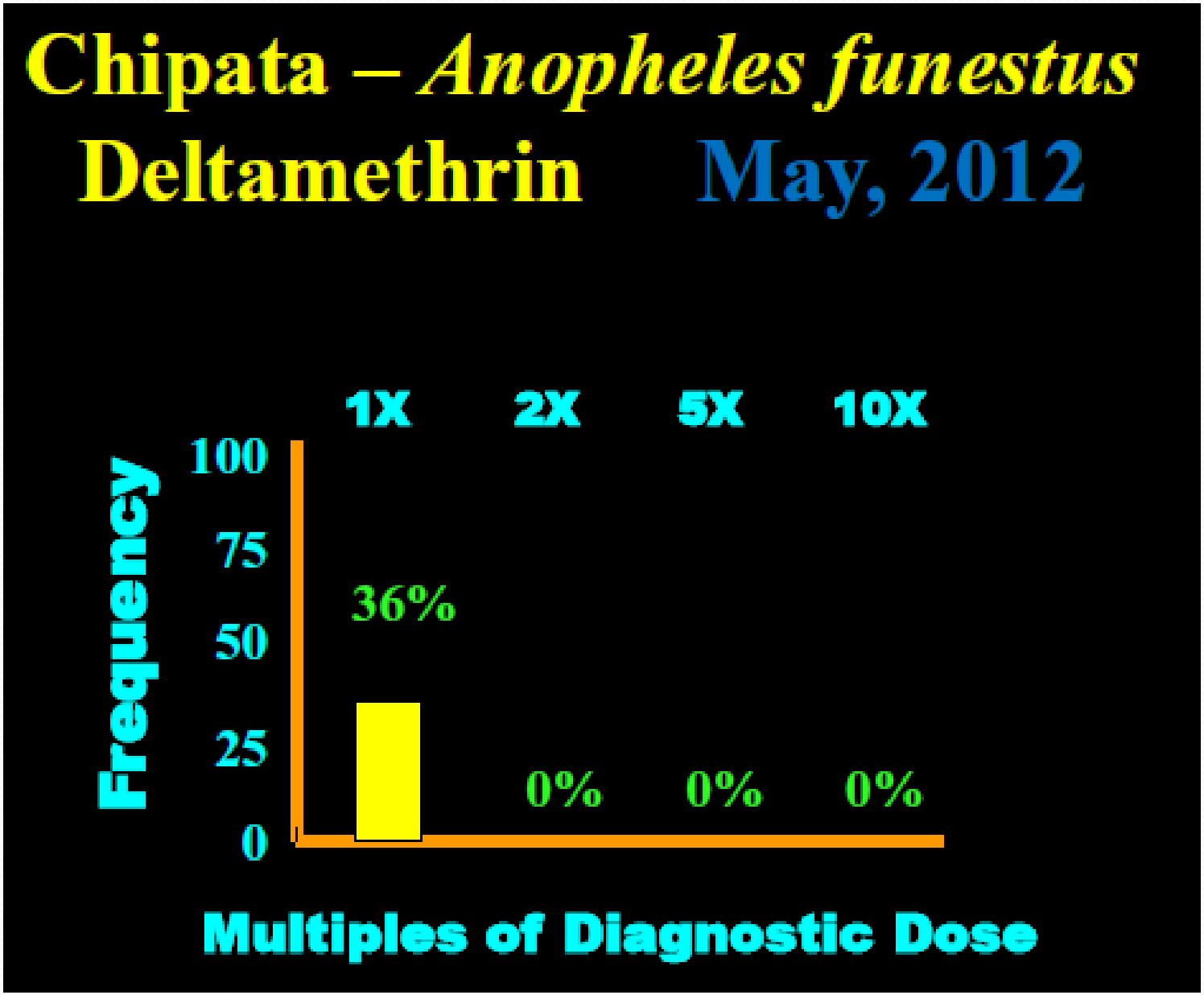


Chipata – *Anopheles funestus*

Deltamethrin February, 2012



After IRS (pirimphos methyl)…



Conclusions

- The bottle bioassay is a simple, standardized test which can detect resistance
- The use of synergists allows preliminary detection of the resistance mechanisms present in a population
- The intensity bioassay may be an effective way of determining “operationally significant” resistance
- These bioassays provide a sound basis for implementing resistance management strategies