Is implementing full coverage of long lasting insecticidal nets (LLINs) a good alternative strategy after indoor residual spraying (IRS) cessation or abandonment?

Razaki Ossè[1,2] and Martin AKOGBETO[1,2*]

Email: akogbetom@yahoo.fr

1-Centre de Recherche Entomologique de Cotonou (CREC), 06 BP 2604 Cotonou, République du Bénin; 2-Faculté des Sciences et Techniques de l'Université d'Abomey-Calavi (FAST/UAC), République du Bénin.

INTRODUCTION

Since 2008, the National Malaria Control Program (NMCP) has been engaged in the implementation of indoor residual spraying (IRS) in the department of Ouémé, in southern Benin. The first and second round were successful with a drastic decrease of malaria transmission in areas under IRS. Despite this success and considering the cost of this strategy, NMCP has decided to move IRS from this district to others where a single round of IRS would be sufficient to protect the same size of population against malaria. However, in order to maintain low incidence level even after the cessation of IRS in Ouémé, a full coverage of long lasting insecticidal net (LLIN) was achieved in the households by the NMCP.
Will this strategy be a good alternative after indoor residual spraying (IRS) cessation or abandonment?

METHODS

Study area

The full coverage of LLINs was done in four districts (Adjohoun, Dangbo, Missérété and Sèmè) which previously, were treated with 0,4g/m² dosage of bendiocarb applied to the walls of the houses in Ouémé department. Olyset nets were distributed to the whole population in the four districts. These nets were treated with 2% of permethrin.

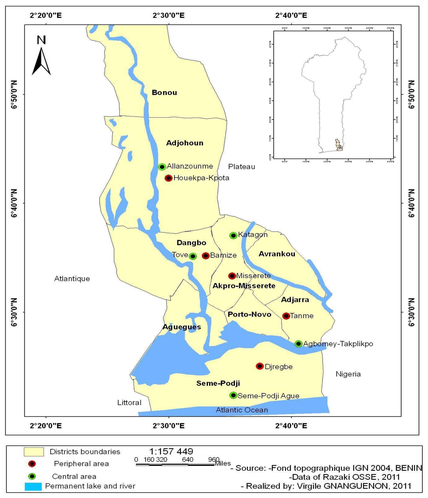

Figure 1: Map of the study area showing localities chosen in central and peripheral areas

Mosquito sampling and treatment

Indoor collections of adult mosquitoes were carried out monthly from January to December 2011.
Collections were organized in in both central and peripheral zones. Adult mosquitoes were collected using three sampling methods:
(1) Indoor and outdoor Human Landing Catches (HLC) performed monthly over two consecutive nights (9:00 PM to 5:00 AM), in 4 randomly selected compounds;
(2) Window exit traps were used for mosquitoes collection;
(3) Indoor Pyrethrum Spray Catches (PSC) in 4 other selected compounds; the same compounds in each sampling method being consistently used throughout the study.
Collectors gave prior informed consent and received anti-malaria prophylaxis and yellow fever immunization. They were organized in teams of two for each collection point and they rotated between location within houses every two hours.
Mosquitoes from HLC were used to evaluate the sporozoite infection rate (EIR), the human bite rate (HBR), and parity rate of *Anopheles gambiae*. Furthermore, mosquitoes from window exit traps were used to evaluate the exophily rate and these from PSC for blood feeding.

Human Landing catch

1

Window exit trap

2

Morning pyrethrum spray catches

3

RESULTS

1- Mosquito human biting rates (HBR) recorded during the IRS campaign and after IRS cessation

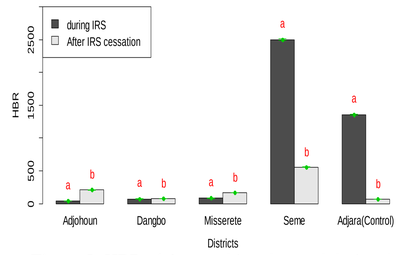

Figure 2: HBR of *An. gambiae* observed during the IRS campaign and after stopping IRS in central area.

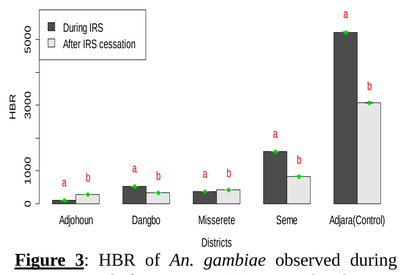

Figure 3: HBR of *An. gambiae* observed during the IRS campaign and after stopping IRS in peripheral area.

A significant increase of *An. gambiae* HBR was recorded in Adjohoun, Dangbo and Missérété after IRS cessation ($p<0.001$). But regarding both areas in Sèmè and the peripheral areas in Dangbo, the HBR after IRS cessation dropped significantly compared to the intervention period ($p<0.001$).

2- Anopheles longevity increase after IRS cessation

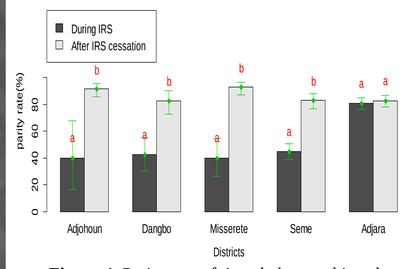

Figure 4: Parity rate of *Anopheles gambiae* observed during the implementation of IRS and after stopping IRS

The proportion of female mosquitoes that spawned at least once was significantly higher mainly after IRS cessation no matter the district (OR = 3.81, $p<0.001$). In the control area, on the other hand, the parity rate was the same in both periods (OR = 1.13, $p = 0.54$).

3- Blood feeding rate increase of mosquitoes inside the houses after IRS cessation

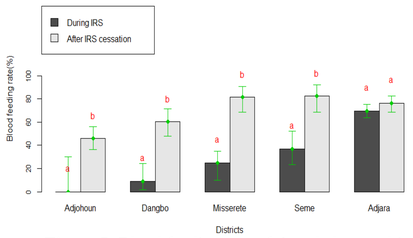

Figure 5: Blood feeding rate of *Anopheles gambiae* observed during the implementation of IRS and after stopping IRS

The blood feeding rate obtained after IRS cessation was significantly higher than that recorded during IRS intervention in all districts (OR = 1.48, $p <0.001$) (46.08% in Adjohoun, 60.27% in Dangbo, 81.48% in Missérété and 82.61% in Sèmè).

4- Impact of IRS cessation on the entomological inoculation rate (EIR) in areas under IRS intervention

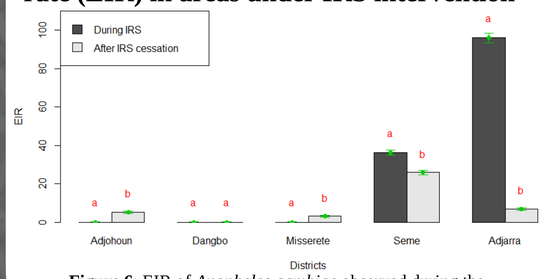

Figure 6: EIR of *Anopheles gambiae* observed during the implementation of IRS and after stopping IRS

The EIR was three times higher after IRS cessation in Adjohoun (9.015 infected bites/person against 3.66 during IRS intervention) and six times higher in Missérété after IRS cessation than that recorded during IRS intervention (15.08 infected bites against 2.41 during IRS intervention). But it was rather the contrary that was observed in Sèmè and Dangbo after IRS cessation.

5- Exophily reduction induced by bendiocarb in *An. gambiae* after IRS cessation

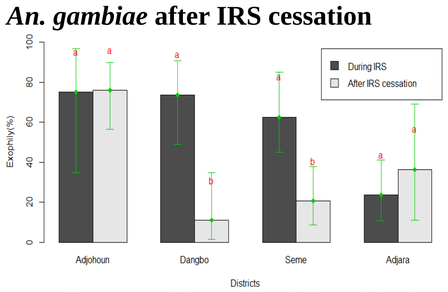

Figure 7: Exophily rate of *Anopheles gambiae* observed during the implementation of IRS and after stopping IRS

The exophily degree didn't vary after IRS cessation in Adjohoun. Yet, in the other three districts, a significant drop was observed after IRS cessation in all of the zones ($p<0.001$).

DISCUSSION

An increase level of malaria incidence was observed in the districts after IRS cessation. At Adjohoun and Missérété, the EIR obtained after IRS cessation (9 months) was significantly higher than that what obtained during the intervention. ($p< 0.001$). This can be explained by the absence of bendiocarb which before created a bad environnement for the survival of mosquitoes (Kelly-Hope et al, 2008; Akogbéto et al., 2011).
The presence of Olyset nets in houses after IRS cessation had impacted positively malaria transmission. This can be explained by the fact that *An. gambiae* has developed resistance against pyrethroids (Padonou et al, 2012) and confirm the results of N'Guessan et al..(2007).

CONCLUSION

This study showed once again the successfulness of IRS strategy. Mosquitoes were more likely to rest in houses with LLINs, than in houses subjected to IRS. However, for better reduction of malaria transmission, it will be very important to combine the two (IRS +LLIN) strategies.

This work was supported by the USAID through the Presidential Initiative Malaria