I2I Landscaping exercise

Track Sprayer

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Acronym List

AI	Active ingredient
I2I	Innovation to Impact
IHI	Ifakara Health Institute
IRS	Indoor residual spraying
LITE	Liverpool Insect Testing Establishment
LSTM	Liverpool School of Tropical Medicine
PT	Potter Tower
SOP	Standard operating procedure
TS	Track sprayer
WHO	World Health Organisation

Summary

Aim and key questions addressed	- Used a method of chemical spraying in the laboratory. - Use is intended to provide a homogenous residual deposit of the desired concentration of active ingredient per unit area
Context	- Laboratory
Test item	- Indoor residual spraying (IRS) formulations
Mosquito population	- N/A
Number of mosquitoes per replicate	- N/A
Endpoints measured	- N/A
Exposure time	- N/A
Holding time	- N/A
Indicative of personal protection	- N/A

Suitable chemistries	- IRS formulations
Appropriate controls	- N/A
Relevant stage of production pipeline	- Product development - Bioefficacy assessment
Characterisation of output	- Ongoing
Accessibility	- Materials need to be sourced and training is required
Cost	- Cost of equipment and time to train staff
Level of validation and characterisation of outputs	– There is a need for further validation within and between sites
Outstanding questions, gaps and priorities	- There is a need for further validation within and between sites
Key references, related SOPs, guidelines and publications	- Bonds, J., Parsons, G., Walker, K. J., Lees, R. S., Murphy, A., Malone, D., & Foundation, M. G. (2023). Comparative analysis of the Potter Tower and a new Track Sprayer for the application of residual sprays in the laboratory. Preprint, 1–21. Retrieved from

	https://assets.researchsquare.com/files/rs-2598764/v1/e3c3bf06-3c59-4b67-b93e-1a7a09fc44d0.pdf?c=1677080217

Overview

Accurately treated surfaces are required for the evaluation of new insecticide-based products for control of *Aedes* and *Anopheles* mosquitoes, as well as for laboratory and semi-field research activities. The Potter Tower is routinely used to apply formulations to test surfaces but offers low throughput, limited reproducibility in spray rate, is challenging and slow to calibrate to the desired dosing accuracy of +/- 10% and is only able to treat a 9cm diameter circle area. The ability to treat a larger area accurately and reproducibly would be invaluable for research, particularly studies of mosquito behaviour. The need for improved spray equipment in the development and evaluation of new indoor residual spraying (IRS) formulations was mentioned by several commercial producers of vector control tools during a recent consultation of industry partners performed for I2I as delaying the route to market.

Improved reproducibility and standardisation of application of insecticide to IRS-treated test surfaces (WHO., 2015) will allow better data to be generated in the development and evaluation of vector control tools, and in the monitoring for emerging resistance in target populations to inform deployment choices. Micron Sprayers Ltd have created the horizontal track sprayer for this purpose, which also replicates the application techniques used for application in the field due to similarities in compression sprayers and distance sprayed. Internal validation testing has confirmed that the Micron horizontal track sprayer is an improvement on the Potter Tower in efficiency and accuracy of IRS formulation applications onto test substrates and it produces a more precise delivery of the intended dose of insecticide formulation, with greater flexibility in the size of surfaces that can be treated.

Define Accepted Methodologies

Are there existing standard SOPs/Guidelines detailing methodologies?

During its development for testing an SOP was developed by the Liverpool Insect Testing Establishment (LITE) (Liverpool, UK), and this has been adapted by I2I and is currently under validation.

- ‘Operation and Maintenance of the Track Sprayer’ LITSOP154
- ‘Operation and Maintenance of the Track Sprayer’ I2I-SOP-025

Are these methods sufficiently detailed?

Potential sources of variation may include the laboratory conditions (humidity and temperature). To control this, treating of surfaces takes place within an enclosed chamber in a room temperature laboratory where the temperature/humidity is recorded during spraying. Following treatment surfaces are routinely kept in a stability cabinet in LITE which is temperature and humidity controlled (30°C and 80%) and the AI used (some may be more vicious and harder to generate an even spray, some may disassociate from the formulation).

Do these methods require specialised/non-standardised equipment and/or training?

Training is required for the operation of the track sprayer and for the calibration steps prior to spraying. Calibration involves the use of a fluorescent tracer to generate a calibration curve which enables the deposited volumes of unknown samples to be determined. A fluorometer is required for this step and training in this piece of equipment is needed. No additional specialist training is required.

Are there issues with the methods or their interpretation?

N/A

What AIs or combinations of AIs have the methods been used for?

Actellic and K-otherine and Sumishield

Are the methods validated, for which AIs/entomological effects, and to what extent?

Validation of the Track Sprayer (TS) has been carried out by direct comparison against the Potter Spray Tower (PT) which is the current industry standard for applications of IRS formulations (Bonds et al., 2023). This is conducted by spraying AIs (mainly K-otherine) using both the potter tower and the track sprayer and comparing the variance to show higher precision is achieved with the track sprayer.

This has been conducted using the application of two IRS products, K-othrine and Actellic onto ceramic tiles using both the Potter Tower and Track Sprayer for a direct comparison determining the efficiency and accuracy of IRS formulation applications, specifically exploring the following parameters:

Deposition of the active ingredient onto the surface: assessed by HPLC and fluorometry.

Uniformity of spray deposits: assessed by fluorometry.

Residual efficacy: using standard WHO cone bioassays 8 months post IRS application, at monthly intervals to determine mortality on a susceptible mosquito strain.

The time required for the calibration, operation and cleaning of the PT and TS was also calculated to compare the cost effectiveness of both methods.

The results showed that both sprayers can effectively calibrate the correct deposit, however the uniformity of the spray deposits was higher for the TS compared to the PT and the residual efficacy was better with the surfaces treated from the TS.

The TS was also found to have a higher throughput and a reduced cost per treated surface (25-35 times cheaper per sprayed tile) in comparison to the PT due to its ability to treat multiple surfaces in a single application.

The track sprayer is also currently being internally and externally validated by I2I across two sites at the Liverpool School of Tropical Medicine (LSTM) and Ifakara Health Institute (IHI). This is achieved by spraying fluorescein dissolved in water and comparing the application dosage from many replicates within a day, across several days, and also across the two sites.

What inputs need to be characterised?

The track sprayer needs to be calibrated prior to use to ensure an accurate dosage application onto sprayed surfaces.

Are endpoints clearly defined and appropriate? Who were they defined by?

Yes, the concentration of sprayed sample defined by manufactures.

Are their supporting SOPs?

Not currently but there will be supporting SOPs in the future for using the sprayed surfaces in bioassays e.g., mosquito rearing and cone bioassay SOPs.

Define Current Use Practices

The track sprayer is a newly developed tool. Therefore, there has been little use or testing of this method. Micron manufactured this to spray surfaces with insecticides to simulate IRS. There will be market research conducted to identify whether the track sprayer will have other use cases. One envisaged use for it is to conduct high-throughput treatment of World Health Organisation (WHO) standardised insecticide-treated papers for insecticide resistance monitoring.

Identify Potential Sources of Variation

What are the sources of variability in the method, and are their means to minimise or characterise these?

Potential sources of variation include laboratory conditions which may affect the way the sample is sprayed (temperature and humidity), different types of active ingredients used.

Do current method/s need to be adapted for new active ingredients/MoA/types of tool?

I2I are currently validating the track sprayer without insecticide and aim to move on to insecticides currently used for IRS.

Are new methods required? Identify areas where current method/s are not suitable or sufficient.

N/A

Gaps in biological or other understanding that hinder method development or validation

With the growing need to evaluate IRS formulations containing novel insecticides, researchers need a more reliable and efficient methods for treatment applications. While pyrethroids give rapid knockdown and kill at relatively low application rates, new compounds in development may have an endpoint such as delayed mortality (the pro-insecticide chlorfenapyr for example) or sterilization (pyriproxyfen) which may be more sensitive to deviations from actual target dose application rates. It is therefore essentials to treat test surfaces accurately to minimise the effect of variability in application rates on bioassay endpoints.

Additionally, in less well controlled environmental conditions, the effects of aerosolisation and water droplet physics may not be well understood and could benefit from further research.

Prioritisation – is there an issue that needs to be addressed, what specifics, how urgent is the need?

Potential issues that may arise with the track sprayer are proving reliability across different AIs as we are unsure how they may interact with the sprayer.

There is a need to conduct validation across multiple centers.

References

Bonds, J., Parsons, G., Walker, K. J., Lees, R. S., Murphy, A., Malone, D., & Foundation, M. G. (2023). Comparative analysis of the Potter Tower and a new Track Sprayer for the application of residual sprays in the laboratory. *Preprint*, 1–21. Retrieved from https://assets.researchsquare.com/files/rs-2598764/v1/e3c3bf06-3c59-4b67-b93e-1a7a09fc44d0.pdf?c=1677080217

World Health Organization., (2015). *An Operational Manual for Indoor Residual Spraying (IRS) for Malaria Transmission Control and Elimination*.

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