

VOLUME 5

Title

**Spartan Mosquito Eradicator Pro Tech
EPA Reg. No. 93813-R
Anopheles Species Weight of Evidence Bridging Rationale**

Data Requirements

*Invertebrate Control Agent Product Performance Testing Guidelines
(OCSPP Guideline 810.3400)
Mosquito, Black Fly, and Biting Midge (Sand Fly) Treatments*

Authors

Micah T. Reynolds

Prepared by

Technology Sciences Group, Inc.
1150 18th Street NW, Suite 1000
Washington, DC 20036

Conducting Laboratory

Not Applicable

Date Completed

August 19, 2019

Sponsored/Submitted by

AC2T dba Spartan Mosquito
P.O. Box 18556
Hattiesburg, Mississippi 39404


Study ID

AC2T-20190819-5

STATEMENT OF NO DATA CONFIDENTIALITY CLAIMS

No information is claimed confidential on the basis of its falling within the scope of FIFRA §10(d)(1)(A), (B) or (C).

Company: AC2T dba Spartan Mosquito
P.O. Box 18556
Hattiesburg, Mississippi 39404

Company Agent: 
Micah T. Reynolds,
Regulatory Consultant to AC2T dba Spartan Mosquito
Technology Sciences Group, Inc.

Date: August 19, 2019

NOTICE

This report is the property of AC2T dba Spartan Mosquito and, as such, is considered to be confidential for all purposes other than compliance with FIFRA Section 10. Submission of this report in compliance with FIFRA does not constitute a waiver of any right to confidentiality that may exist under any other statute or in any other country.

GOOD LABORATORY PRACTICES STATEMENT

This study volume is a summary compilation of references to provide a weight of evidence and rationale and as such, it does not meet nor is it subject to the requirements of 40 CFR Part 160.

**Sponsor /
Submitter:**



Micah T. Reynolds,
Regulatory Consultant to AC2T dba Spartan Mosquito
Technology Sciences Group, Inc.

Date:

August 19, 2019

Table of Contents

Study Title Page	1
Statement Of No Data Confidentiality Claims	2
Good Laboratory Practices Statement	3
Table of Contents	4
Anopheles Mosquito Species Bridging Rationale	5
List of Attachments and References Cited	8

Anopheles Mosquito Species Bridging Rationale

Introduction

The Spartan Mosquito Eradicator Pro Tech product is intended to be used and effective against all mosquitoes that may inhabit an area to be treated with the product, and it is understood that efficacy data are needed on multiple mosquito species (i.e. *Culex*, *Aedes*, and *Anopheles*) in order to claim product effectiveness against the general class of mosquitoes. During its evaluation of the product, the registrant has conducted various field efficacy trials with different geographical features (i.e. rural wooded areas, residential wooded areas, coastal areas, and areas proximate to water bodies) that are representative of mosquito habitats. In addition to the field efficacy studies that demonstrate 98%-100% efficacy consistent with the product's labeled claims, the registrant also conducted laboratory efficacy evaluations to demonstrate that varying concentrations of boric acid are effective at controlling both *Culex* and *Aedes* mosquitoes. Coupled with the study data developed by the registrant, there is a wealth of published literature on the effectiveness of attractive toxic sugar bait products in mosquito control (of which boric acid is a popular active ingredient). Significant scientific investigation has determined that such products are widely effective across all mosquito genera, including *Culex*, *Aedes*, and *Anopheles* mosquitoes. It is proposed in this rationale that there is sufficient information in published literature that boric acid-based mosquito attract-and-kill products are effective in the control of all three mosquito genera. Specifically, the registrant requests that the Agency consider the weight of evidence in the public literature in determining that the Spartan Mosquito Eradicator Pro Tech product will perform in the same manner against *Anopheles* mosquitoes as it has been demonstrated to perform against *Culex* and *Aedes* mosquitoes.

Product Background

The Spartan Mosquito Eradicator Pro Tech is a unique pesticide product for the control and suppression of mosquito populations. It is an attractive insecticide bait product containing 9.04% boric acid as the toxicant; however, in-use diluted concentration is 2.3% boric acid once warm water is added to the product. Other inert ingredients in the product are used to attract mosquitoes and once the product is ingested, boric acid will kill the target pest. Mosquito populations will begin to decline and, within two weeks, effective control will last for 30 days. Prior to placement of the product tubes along the perimeter of the area to be treated, warm water is added to the product to initiate attractancy. A specialized cap is placed onto the tube with openings large enough only for mosquitoes to gain access and enter but small enough that other non-target organisms, such as honeybees, butterflies, or hummingbirds, cannot access the product. This specialized cap also affords the ability for the product tube to naturally replenish with rain water over the life of the product as initial water levels may decrease due to evaporative losses.

Demonstrated Laboratory Efficacy Against *Culex* and *Aedes* Species and Field Efficacy

In a laboratory study (MRID No. 50904503), the registrant evaluated the effectiveness of differing concentrations of boric acid and sugar solutions in the control of *Culex quinquefasciatus* and *Aedes aegypti* mosquitoes. Several boric acid formulations that represented diluted versions of the Spartan Mosquito Eradicator Pro Tech product were evaluated. A 1.0% boric acid in 10% sugar/water solution was tested to represent an overly diluted product used in the field, and a 3.0% boric acid in 10% sugar/water solution was tested to represent an evaporated product used in the field along with a 10% sugar/water solution to serve as control. Mosquito mortality data were collected over the course of a 14-day test period. Both test concentrations of boric acid (1.0% and 3.0%) yielded very effective outcomes. For *Culex quinquefasciatus* mosquitoes, 100% control was achieved within 3 days for both

test groups; and for *Aedes aegypti*, 100% control was achieved within three days for the 1.0% group with greater than 95% control being achieved within three days followed by 100% control within six days for the 3.0% group.

The registrant also evaluated the Spartan Mosquito Eradicator Pro Tech product in varied geographic locations representative of mosquito habitat in the Southeastern United States (MRID No. 50904504). While it is understood that the species of collected mosquitoes were not identified from collected control groups of those studies, it is considered justified that a predominant mosquito species that inhabits the Southeastern United States is *Anopheles quadrimaculatus*. Considering that treated areas in the field efficacy studies achieved 98%-100% efficacy, it is reasonable to presume that any *Anopheles* mosquito that was attracted to and consumed the boric acid solution was also controlled by the product.

General Effectiveness of Attractive Toxic Sugar Bait Products

Mosquitoes readily feed on carbohydrates as a nutrient source and multiple investigations have been conducted to determine the effectiveness of attractive sugar bait products – both using fruit derivations and sucrose solutions. Various oral toxicants have been added to those sugar bait solutions to produce attractive toxic sugar baits (ATSBs) on which mosquitoes readily feed and then are killed. Boric acid (typically at 1.0%) has been evaluated extensively in these ATSBs in various locations under differing climatic and geographic conditions over the past fifteen years. Across a variety of geographic locations, ATSB products demonstrate consistent performance in the attract-and-kill mechanism for controlling mosquito populations. Sugar bait products readily attract 90% of more of the native mosquito populations across multiple genera (i.e. *Culex*, *Anopheles*, and *Aedes*) (Qualls, 2012). When boric acid at 1.0% is added to make an ATSB product, high mortality rates have been consistently demonstrated against *Aedes* mosquitoes (Hossain, 2014; Xue, 2011; Rivera, 2016; Xue, 2006). Similar high mortality rates were observed across multiple genera (*Aedes*, *Culex*, *Anopheles*, and *Ochlerotatus*) using 1.0% boric acid attractive toxic sugar bait products as either spray formulations onto foliage or stationary bait stations (Xue, 2006).

Specific Effectiveness of Boric Acid and Sugar Bait Products against *Anopheles* Mosquitoes

In addition to investigations performed to determine effectiveness of ATSB products across multiple genera of mosquitoes, additional studies support its specific effectiveness against several species of *Anopheles* mosquitoes. Early in the research of ATSB products, lethal concentrations were determined for boric acid ATSBs across several mosquito species. At 24 hours, LC₅₀ values for male and female *Anopheles quadrimaculatus* mosquitoes were 0.317% and 0.885%, respectively. At 48 hours, LC₅₀ values for male and female *An. quadrimaculatus* mosquitoes were measured to be 0.101% and 0.395%, respectively (Xue, 2003). Compared to the in-use concentration of the registrant's product (2.3%), high mortality of *Anopheles* mosquitoes is expected. Studies conducted in Israel and Africa, the latter where many malaria-causing *Anopheles* species are prevalent, demonstrated high mortality using 1.0% boric acid ATSB products applied as surface sprays or as stationary bait stations. Greater than 90% control was achieved in *An. gambiae* (Qualls, 2015), *An. sergentii* (Beier, 2012), and *An. gambiae* and *An. arabiensis* (Muller 2010) following 1.0% boric acid ATSB spray or placement (for stationary bait stations).

Summary

It is reasonable to conclude that the Spartan Mosquito Eradicator Pro Tech product is effective in the control of *Anopheles* mosquitoes in a similar way that it is effective in the control of *Culex* and *Aedes* mosquitoes therefore supporting a general effectiveness claim against mosquitoes. The registrant's

conducted research confirming control of *Culex* and *Aedes* mosquitoes coupled with the field trial research on native mosquitoes substantiates that all mosquito species will be controlled by the product, particularly due to the 98%-100% observed rate of control during the field trials. In addition, study results of investigations by previous researchers concludes that boric acid-based ATSB products are highly effective in the control of multiple genera of mosquitoes including multiple species of *Anopheles* mosquitoes, including *An. gambiae*, *An. sergentii*, and *An. arabiensis*).

List of Attachments and References Cited

- Allan, S.A. 2011. Susceptibility of adult mosquitoes to insecticides in aqueous sucrose baits. *Journal of Vector Ecology* **36**(1): 59-67.
- Bonner, M. Laboratory Efficacy Evaluation Against Mosquitoes. Study ID: AC2T-20190729-3. MRID No. 50904503.
- Beier, J.C., Muller, G.C., Gu, W., Arheart, K.L., and Y. Schlein. 2012. Attractive toxic sugar bait (ATSB) methods decimate populations of *Anopheles* malaria vectors in arid environments regardless of the local availability of favoured sugar-source blossoms. *Malaria Journal* **11**:31.
- Cornel, A.J., Lee, Y., Almeida, A.P.G., Johnson, T., Mouatcho, J., Venter, M., De Jager, C., and L. Braack. 2018. Mosquito community composition in South Africa and some neighboring countries. *Parasites & Vectors* **11**:331.
- Endo, N. and E.A.B. Altahir. 2018. Modelling and observing the role of wind in *Anopheles* population dynamics around a reservoir. *Malaria Journal* **17**:48.
- Hossain, T.T., Fulcher, A., Davidson, C., Beier, J.C., and R. Xue. 2014. Evaluation of boric acid sugar baits sprayed on plants against the salt marsh mosquito, *Aedes taeniorhynchus* (Diptera: Culicidae). *Florida Entomologist* **97**(4): 1865-1868.
- Marshall, J.M., White, M.T., Ghani, A.C., Schlein, Y., Muller, G.C., and J.C. Beier. 2013. Quantifying the mosquito's sweet tooth: modelling the effectiveness of attractive toxic sugar baits (ATSB) for malaria vector control. *Malaria Journal* **12**:291.
- McPhatter, L., and A.C. Gerry. 2017. Effect of CO₂ concentration on mosquito collection rate using odor-baited suction traps. *Journal of Vector Ecology* **42**(1): 44-50.
- Muller, G.C., Beier, J.C., Traore, S.F., Toure, M.B., Traore, M.M., Bah, S., Doumbia, S., and Y. Schlein. 2010. Successful field trial of attractive toxic sugar bait (ATSB) plant-spraying methods against malaria vectors in the *Anopheles gambiae* complex in Mali, West Africa. *Malaria Journal* **9**:210.
- Muller, G.C., Beier, J.C., Traore, S.F., Toure, M.B., Traore, M.M., Bah, S., Doumbia, S., and Y. Schlein. 2010. Field experiments of *Anopheles gambiae* attraction to local fruits/seedpods and flowering plants in Mali to optimize strategies for malaria vector control in Africa using attractive toxic sugar bait methods. *Malaria Journal* **9**:262.
- Qualls, W.A., Muller, G.C., Traore, S.F., Traore, M.M., Arheart, K.L., Doumbia, S., Schlein, Y., Kravchenko, V.D., Xue, R., and J.C. Beier. 2015. Indoor use of attractive toxic sugar bait (ATSB) to effectively control malaria vectors in Male, West Africa. *Malaria Journal* **14**:301.
- Qualls, W.A., Xue, R., Revay, E.E., Allan, S.A., and G.C. Muller. 2012. Implications for operational control of adult mosquito production in cisterns and wells in St. Augustine, FL using attractive sugar baits. *Acta Tropica* **124**:158-161.
- Revay, E.E., Schlein, Y., Tsabari, O., Kravchenko, V., Qualls, W., De-Xue, R., Beier, J.C., Traore, S.F., Doumbia, S., Hausmann, A., and G.C. Muller. 2015. Formulation of attractive toxic sugar

bait (ATSB) with safe EPA-exempt substance significantly diminishes the *Anopheles sergentii* population in a desert oasis. *Acta Tropica* **150**: 29-34.

Rivera, G.E. 2016. Developing a novel attractive toxic sugar bait (ATSB) device for intra-domiciliary control of *Aedes aegypti*. Dissertation. *Center for Research on Health in Latin America, College of Exact and Natural Sciences, Pontifical Catholic University of Ecuador, Quito, Ecuador*.

Wang, F., Shen, Y., Dixon, D., and R. Xue. 2017. Control of male *Aedes albopictus* Skuse (Diptera: Culicidae) using boric acid sugar bait and its impact on female fecundity and fertility. *Journal of Vector Ecology* **42**(1): 203-206.

Xue, R. and D.R. Barnard. 2003. Boric acid bait kills adult mosquitoes (Diptera: Culicidae). *Journal of Economic Entomology* **96**(5): 1559-1562.

Xue, R., Kline, D.L., Ali, A., and D.R. Barnard. 2006. Application of boric acid baits to plant foliage for adult mosquito control. *Journal of the American Mosquito Control Association* **22**(3): 497-500.

Xue, R., Muller, G.C., Kline, D.L., and D.R. Barnard. 2011. Effect of application rate and persistence of boric acid sugar baits applied to plants for control of *Aedes albopictus*. *Journal of the American Mosquito Control Association* **27**(1): 56-60.

Zhou, Y., Zhang, Z., Fu, Y., Zhang, G., and S. Yuan. 2018. Carbon dioxide, odorants, heat and visible cues affect wild mosquito landing in open spaces. *Frontiers in Behavioral Neuroscience* **12**:86.

Zhu, L., Marshall, J.M., Qualls, W.A., Schlein, Y., McManus, J.W., Arheart, K.L., Hlaing, W.M., Traore, S.F., Doumbia, S., Muller, G.C., and J.C. Beier. 2015. Modelling optimum use of attractive toxic sugar bait stations for effective malaria vector control in Africa. *Malaria Journal* **14**:492.