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A FIELD EFFICACY EVALUATION OF IN2CARE MOSQUITO TRAPS IN COMPARISON WITH ROUTINE INTEGRATED VECTOR MANAGEMENT AT REDUCING *AEDES AEGYPTI*

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ABSTRACT. *Aedes aegypti* is the predominant vector of dengue, chikungunya, and Zika viruses. This mosquito is difficult to control with conventional methods due to its container-inhabiting behavior and resistance to insecticides. Autodissemination of pyriproxyfen (PPF), a potent larvicide, has shown promise as an additional tool to control *Aedes* species in small-scale field trials. However, few large-scale field evaluations have been conducted. We undertook a 6-month-long large-scale field study to compare the effectiveness and operational feasibility of using In2Care Mosquito Traps (In2Care Traps, commercially available *Aedes* traps with PPF and *Beauveria bassiana*) compared to an integrated vector management (IVM) strategy consisting of source reduction, larviciding, and adulticiding for controlling *Ae. aegypti* eggs, larvae, and adults. We found that while the difference between treatments was only statistically significant for eggs and larvae ($P < 0.05$ for eggs and larvae and $P > 0.05$ for adults), the use of In2Care Traps alone resulted in 60%, 57%, and 57% fewer eggs, larvae, and adults, respectively, collected from that site compared to the IVM site. However, In2Care Trap deployment and maintenance were more time consuming and labor intensive than the IVM strategy. Thus, using In2Care Traps alone as a control method for large areas (e.g., >20 ha) may be less practical for control programs with the capacity to conduct ground and aerial larviciding and adulticiding. Based on our study results, we conclude that In2Care Traps are effective at suppressing *Ae. aegypti* and have the most potential for use in areas without sophisticated control programs and within IVM programs to target hotspots with high population levels and/or risk of *Aedes*-borne pathogen transmission.

KEY WORDS *Aedes aegypti*, container-inhabiting mosquitoes, field evaluation, In2Care traps, mosquito control

INTRODUCTION

Aedes aegypti (L.) is the predominant mosquito species responsible for transmitting dengue, chikungunya, yellow fever, and Zika viruses (Kauffman and Kramer 2017). Due to the widespread distribution of *Aedes* vectors and an increase in urbanization, globalization, and worldwide travel within the last half-century, the risk of *Aedes*-borne neglected tropical diseases has become a global public health threat (Wilder-Smith and Gubler 2008, Weaver and Reisen 2010, Golding et al. 2015, Kraemer et al. 2016, Leta et al. 2018). *Aedes*-borne viruses have been documented in 58% of all territories worldwide. Dengue alone causes 390 million infections annually, and taken together, all *Aedes*-borne viruses put 3 billion people at risk (Bhatt et al. 2013, Kraemer et al. 2015, Leta et al. 2018). It is expected that the distribution of *Aedes* vectors and the incidences of *Aedes*-borne diseases will only increase due to climate change (Ryan et al. 2019).

Without effective vaccines available for most *Aedes*-borne viral diseases, current disease prevention relies on controlling the mosquito vectors. Integrated vector management (IVM) is a comprehensive approach to mosquito control that incorporates multiple tools like source reduction and larvicidal and adulticidal applications to reduce mosquitoes at different life stages. However, the traditional control methods used within an IVM plan may fall short when combatting urban dwelling *Ae. aegypti* because immature mosquitoes develop in small, cryptic containers that are difficult to detect or reach with ground- or aerial-based larvicide applications (Lloyd et al. 2018). Adult *Ae. aegypti* females also rest in cryptic areas, which may prevent adulticide sprays from reaching them (Dzul-Manzanilla et al. 2017). If adulticide spray droplets do hit flying *Ae. aegypti*, their efficacy may be reduced due to insecticide resistance. Resistance to all 4 insecticide classes of adulticides (carbamates, organochlorines, organophosphates, and pyrethroids) has been documented in *Ae. aegypti* populations worldwide (Ranson et al. 2010, Smith et al. 2016). The potentially limited success of these strategies against *Ae. aegypti* highlights the need for additional tools for controlling populations and preventing *Aedes*-borne disease transmission.

Autodissemination is a method of *Aedes* mosquito control that harnesses the ability of egg-laying *Aedes* females to find containers and contaminate them with insect growth regulators (IGR) that kill their offspring (Caputo et al. 2012, Gaugler et al. 2012). Autodisse-

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mination traps or stations are designed to lure gravid female *Aedes* mosquitoes and contaminate them with IGR particles such as pyriproxyfen (PPF). As *Ae. aegypti* successively visits multiple oviposition sites during "skip oviposition" (Colton et al. 2003), PPF is deposited in those oviposition sites where it affects larval and pupal development, preventing the emergence of adult mosquitoes. Small-scale autodissemination trap field trials have shown that PPF can be successfully dispersed by *Aedes* mosquitoes and reduce juvenile mosquito populations (Devine et al. 2009, Caputo et al. 2012, Kartzinel et al. 2016, Unlu et al. 2017, Hustedt et al. 2020). However, a limited number of large-scale PPF autodissemination field evaluations have been conducted (Ponlawat et al. 2013, Abad-Franch et al. 2015, 2017, Garcia et al. 2020, Hustedt et al. 2020), and even fewer have been conducted at an operationally relevant scale (Abad-Franch et al. 2015, 2017, Garcia et al. 2020, Unlu et al. 2020). Therefore, this study serves as an addition to the growing body of evidence demonstrating that PPF autodissemination can be a successful tool to reduce *Aedes* mosquitoes within operational mosquito control.

Manatee County Mosquito Control District (MCMCD), located in Palmetto, Florida, undertook semifield tests in 2017 with a recently developed US Environmental Protection Agency–registered autodissemination product, called the In2Care Mosquito Trap (In2Care Trap; In2Care B.V., Wageningen, The Netherlands), which combines PPF autodissemination with the entomopathogenic fungus *Beauveria bassiana* (Balsamo-Crivelli) to reduce the emergence of *Aedes* mosquitoes and subsequently kill the contaminated adult females (Snetselaar et al. 2014). Results of these screenhouse studies showed high larvicidal impacts through PPF autodissemination, as well as significant reductions in adult survival of *Ae. albopictus* (Skuse) and *Ae. aegypti* females (Buckner et al. 2017).

Here, we extend previous work to investigate the control impact of In2Care Traps on *Ae. aegypti* densities by executing a 6-month-long large-scale field study in Manatee County, Florida. This field study was conducted during the summer of 2018 in 2 similar residential areas with *Ae. aegypti* populations. We designed the study to enable comparison of the effectiveness and operational feasibility of using In2Care Traps to MCMCD's IVM strategy consisting of surveillance, source reduction, larviciding, and adulticiding. Our study is the first to quantify the impacts of the PPF autodissemination product on *Aedes* densities in a field setting and assess its potential for operational mosquito control.

MATERIAL AND METHODS

Ethics statement

Prior to the beginning of the field trial, each resident in the In2Care Trap site was asked for his/her permission to put the traps on his/her lot. Formal written consent was obtained to place In2Care Traps on 90% of the lots in the In2Care Trap site. Because MCMCD prioritizes serving and protecting the public health of Manatee County residents over research, residents in the In2Care Trap site retained their right to make service requests to address nuisance mosquitoes. Also, if any vector-borne disease threats had presented in the In2Care Trap site, MCMCD planned to conduct additional control measures.

Study sites

This study took place in Manatee County, Florida. We selected 2 suburban neighborhoods with *Ae. aegypti* as our treatment sites for comparison because of their similarity and geographical isolation. Cortez (25 ha) and Longboat Key Village (40 ha) are middle- to middle-to-high income residential neighborhoods, respectively, where most people live in single-family houses with primarily $\leq$0.10 ha lots. A $\geq$15-foot-wide canal isolates Longboat Key Village from the rest of Longboat Key, and State Road 684 isolates Cortez from neighboring areas (Fig. 1). Additionally, the sites are over 2.5 km apart and separated by Sarasota Bay. The isolation of and distance between the sites was intended to minimize interventions "leaking" (i.e., dispersal of PPF-carrying mosquitoes or drift of adulticide spray cloud) into and from the sites (Garcia et al. 2020). It was not feasible to include an untreated control site in this study, because all areas of MCMCD where *Ae. aegypti* is present receive treatment due to this species being an arbovirus vector and nuisance.

The treatment to be used at each site was not randomly assigned. Cortez has historically required interventions to reduce pestiferous *Ae. taeniorhynchus* (Wiedemann) in addition to *Ae. aegypti*. To allow for the likelihood of larviciding and adulticiding treatments for *Ae. taeniorhynchus* as well as *Ae. aegypti* taking place in Cortez during our study, it was designated as the IVM site, and Longboat Key Village was designated as the In2Care Trap site. Additionally, the number and placement of little black jars (LBJ) and BG-Sentinel 2 (BGS2) traps (BioGents Corporation, Regensbourg, Germany) in both sites were chosen in an effort to achieve maximum spatial coverage given our resource and time constraints instead of being chosen by a priori power analysis/sample calculations.

Mosquito surveillance

We conducted mosquito surveillance in the IVM and In2Care Trap sites during a 4-wk-long baseline period and 5-month-long intervention period from April to mid-September 2018 (Fig. 2). In each site, 20 LBJ were placed to collect *Ae. aegypti* eggs and larvae (Reiter et al. 1991, Hoel et al. 2011). These LBJ consisted of glass jars painted black on the outside with 300 ml of water, 0.5 g of a 3:2 mixture

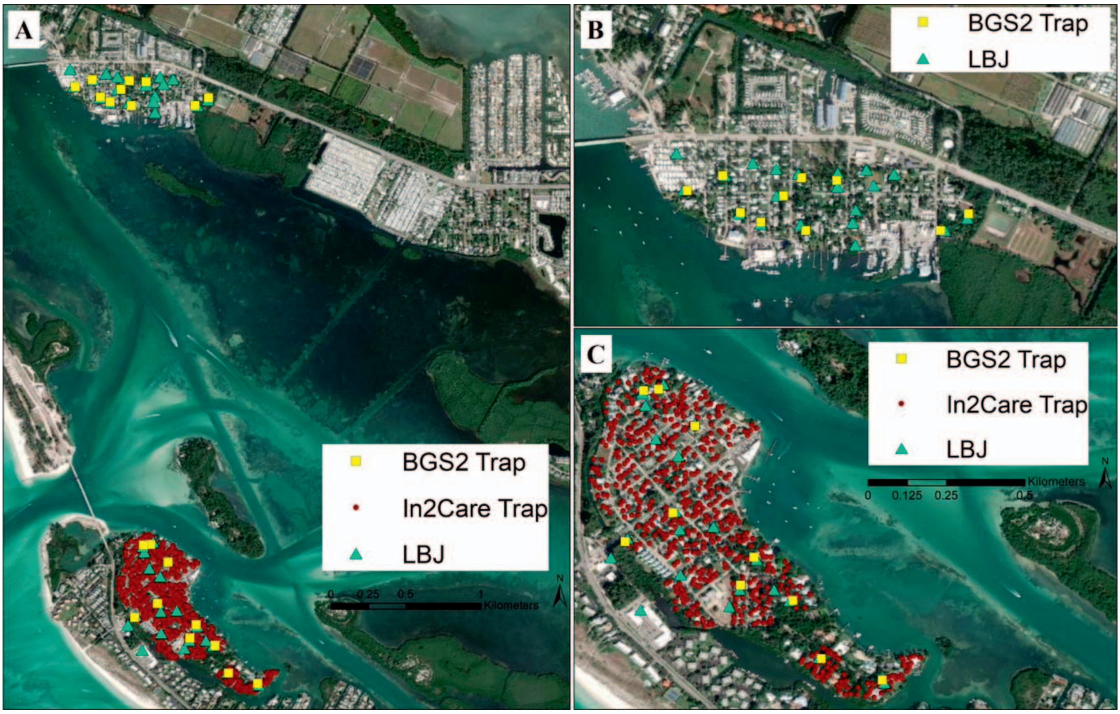

Fig. 1. Maps of the integrated vector management (IVM) and In2Care Mosquito Trap (In2Care Trap) sites. (A) IVM and In2Care Trap sites in relation to each other; (B) Close-up of IVM site showing placement of BG-Sentinel 2 (BGS2) traps and little black jars (LBJ); (C) Close-up of In2Care Trap site showing placement of BGS2 traps, LBJ, and In2Care Traps. Source of map background imagery: ESRI, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS USDA, USGS, AeroGRID, IGN, and the GIS User Community.

of liver powder and brewer's yeast (MP Biomedical, Solon, OH) as oviposition attractant, and a 12.5 × 5 cm strip of seed germination paper (Anchor Paper, St. Paul, MN) as an oviposition substrate. Each week, the oviposition paper was removed from every LBJ, replaced with a new one, and taken back to the laboratory. The number of eggs on the oviposition paper from each of the 20 LBJ was counted using a dissecting microscope and recorded. Additionally, each week the number of mosquito larvae in each LBJ was counted and recorded.

To monitor *Ae. aegypti* adult density, 10 BGS2 traps were used per site. Each BGS2 trap was placed in a suitable spot according to the manufacturer's instructions and baited with a BGLure (BioGents Corporation, Regensbourg, Germany). These traps were run at both sites on the same night each week. All insects in BGS2 catch bags were transported from the field to the laboratory and killed by freezing. Adult mosquitoes were identified to species using standard keys (Darsie Jr and Morris 2003, Darsie Jr and Ward 2005), and for each species, the number collected per trap was recorded.

Treatments

In2Care Traps were placed in permitted lots at a density of 25 traps/ha per manufacturer's recommendation (In2Care 2019), which resulted in installation of 580 traps (Fig. 1). Including the lots where traps were not permitted, the average density of In2Care Traps in the In2Care Trap site was approximately 15 traps/ha. Per hectare (15 In2Care Traps), a team of 10 spent approximately 8 h (300 h total) installing the traps primarily on foot. A team of 4 spent 3 h per hectare every 4 wk (120 h every 4 wk and 480 h total) conducting trap maintenance (Fig. 2), which entailed replacing the gauze, active ingredients, and water in each trap according to the manufacturer's instructions, primarily on foot (Table 1).

MCMCD's surveillance-based IVM strategy, consisting of source reduction, larviciding, and adulticiding, was used to control all nuisance and potential arbovirus vector mosquitoes including *Ae. aegypti* in the IVM site. An MCMCD inspector performed source reduction of potential *Ae. aegypti* larval habitats when found during daily routine inspections. The inspector applied VectoBac GS *Bacillus thuringiensis israelensis* de Barjac (Valent BioSciences, Libertyville, IL) to potential *Ae. aegypti* larval habitats that could not be emptied such as bromeliads and old boats. Approximately 1.5 h each day (150 h total) was spent inspecting, performing source reduction, and larviciding in the IVM site on foot (Table 1).

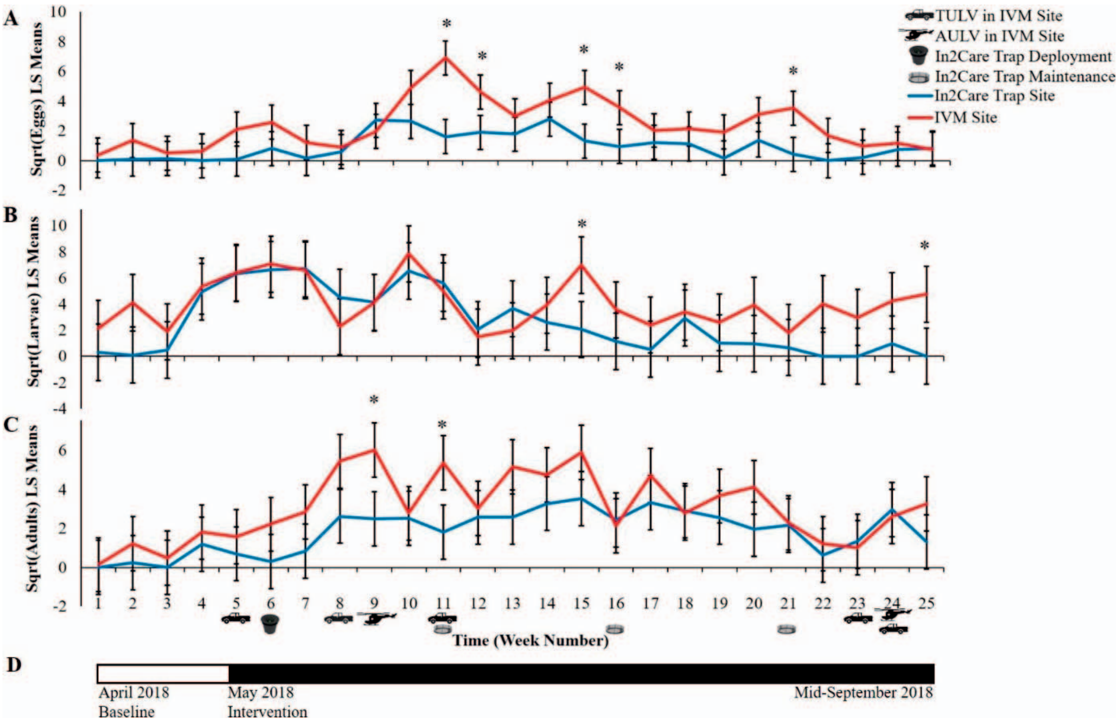

Fig. 2. *Aedes aegypti* weekly mean density in the In2Care Mosquito Trap (In2Care Trap) and integrated vector management (IVM) sites. (A) Mosquito eggs collected in little black jars (LBJ); (B) Mosquito larvae collected in LBJ; (C) Mosquito adults collected in BG-Sentinel 2 traps. Square-root-transformed weekly least squares (LS) means are shown. Asterisk indicates weeks when LS means significantly differed between sites. The timing of aerial and ground ultra-low-volume adulticide applications in the IVM site is indicated by the black truck or helicopter symbol, respectively. The timing of In2Care Trap deployment is indicated by the black In2Care Trap symbol, and the timing of In2Care Trap maintenance in the In2Care Trap site is indicated by the black In2Care Trap floater symbol. (D) Trial timeline.

In addition to performing IVM site-wide source reduction and larviciding, the MCMCD inspector responded to citizen service requests. During a citizen service request, the inspector surveyed the request location for immature and adult mosquitoes. Any mosquitoes found were identified by the inspector. If *Ae. aegypti* larvae were found, source reduction and/or larviciding with VectoBac GS was performed. Any *Ae. aegypti* adults observed were sprayed using a Colt-4 ultra-low-volume (ULV) hand-held Portable Aerosol Generator (London Foggers, Minneapolis, MN), which applied Delta-Gard (Bayer Environmental Science, Cary, NC) diluted 1:5 with water at a rate of 0.0013 lb deltamethrin/acre or Fyfanon EW (FMC Corporation, Philadelphia, PA) diluted 1:6 with water at a rate of 0.011 lb malathion/acre (Table 2). Responding to each citizen service request took the inspector approximately 30 min (Table 1).

Ground and aerial ULV spray missions were performed after sundown as needed in response to citizen service requests and/or high mosquito popu-

Table 1. Total time spent and transportation mode used for each mosquito control activity in the In2Care Mosquito Trap (In2Care Trap) and integrated vector management (IVM) sites during trial.

Site	Activity	Total time spent	Transportation mode
In2Care Trap	Installing traps	300 h	On foot
In2Care Trap	Trap maintenance	480 h	On foot
IVM	Daily inspections, source reduction, larvidicing	150 h	On foot
IVM	Citizen service requests	3.5 h	On foot
IVM	GULV[1]	2.5 h	Truck
IVM	AULV[2]	20 min	Helicopter

[1] Ground ultra-low-volume spray mission.
[2] Aerial ultra-low-volume spray mission.

Table 2. Adulticide missions in the integrated vector management (IVM) site.

Target species	Application method	Product	No. of missions	Week(s) performed
Ae. taeniorhynchus	Aerial	DeltaGard	1	37
Ae. taeniorhynchus	Aerial	Dibrom	1	22
Ae. taeniorhynchus	Ground	DeltaGard	1	18
Ae. taeniorhynchus/Ae. aegypti	Ground	DeltaGard	1	21
Ae. aegypti	Ground	Fyfanon EW	1	24
Ae. taeniorhynchus	Ground	Fyfanon EW	2	36, 37
Ae. aegypti	Hand	DeltaGard	2	26
Ae. aegypti	Hand	Fyfanon EW	5	26, 27, 28 (2), 33

lations, which resulted in 2 aerial and 5 ground ULV spray missions that covered the entire IVM site (Table 2). Each ground ULV spray mission took approximately 30 min, and each aerial ULV spray mission took approximately 10 min in the IVM site (Table 1). A London Fogger Model 18-20 high output ULV aerosol generator (London Foggers) mounted in the back of a pickup truck was used for all ground spray missions. DeltaGard and Fyfanon EW were the 2 products used for ground spray missions. DeltaGard was applied neat (nondiluted) at a rate of 0.0013 lb deltamethrin/acre, and Fyfanon EW was applied neat at a rate of 0.011 lb malathion/acre. Aerial applications were made using a custom-built high-pressure system at 1000 psi on a 1980 McDonell Douglas (MD) 500 Model D helicopter. During aerial missions, either Dibrom (AMVAC Chemical Corporation Newport Beach, CA) was applied neat at a rate of 0.6 lb naled/acre, or DeltaGard was applied neat at a rate of 0.7 lb deltamethrin/acre.

Statistical analyses

A repeated measures analysis of variance was performed using PROC GLIMMIX in SAS 9.4 software (SAS Institute Inc., Cary, NC) to detect the effect of treatment, week, and the interaction between the 2 on the square-root-transformed mean *Aedes* eggs, larvae, and adults collected from the In2Care Trap and IVM sites each week during the field trial. Treatment, week, and their interaction were treated as fixed effects. For eggs and larvae, LBJ was treated as a random effect, and for adults, BGS2 was treated as a random effect. The first-order autoregressive covariance structure for a week was used to account for repeated measures. The level of significance was set to 5% ($\alpha = 0.05$). Significant fixed effects were sliced by week, and post hoc Tukey's tests for differences between treatment least squares (LS) means were conducted for every week.

Table 3. Total eggs, larvae, and adults collected during baseline and intervention periods in the In2Care Mosquito Trap (In2Care Trap) and integrated vector management (IVM) sites.

Site	Period	Eggs	Larvae	Adults
In2Care Trap	Baseline	10	1,962	47
IVM	Baseline	265	284	109
In2Care Trap	Intervention	3,238	10,888	1,896
IVM	Intervention	8,255	25,510	4,363

RESULTS

Mosquito surveillance

In total, 3,248, 12,850, and 1,943 *Aedes* mosquito eggs, larvae, and adults, respectively, were collected from the In2Care Trap site, and 8,520, 25,974, and 4,472 *Aedes* eggs, larvae, and adults, respectively, were collected from the IVM site (Table 3). All mosquitoes that successfully hatched from eggs collected at both sites and survived to adulthood were identified as *Ae. aegypti*. Interestingly, when performing trap maintenance in the In2Care Trap site, we also found *Culex* egg rafts on the water inside some of the In2Care Traps and adult female *Culex quinquefasciatus* Say flying around them.

We detected significant effects of treatment, week, and their interaction on *Ae. aegypti* eggs and larvae collected (Fig. 2, all $P < 0.05$). Week of year and treatment-week interaction were the only effects found to significantly affect *Ae. aegypti* adults collected by BGS2 traps (Fig. 2, all $P < 0.04$). Post hoc Tukey's tests revealed no significant differences in eggs, larvae, and adult mosquitoes collected from the 2 sites during the study's baseline period (all $P > 0.05$), which occurred at the very beginning of the yearly *Ae. aegypti* season (Fig. 2; Table 3).

However, during the intervention period, 60%, 57%, and 57% fewer eggs, larvae, and adults, respectively, were collected from the In2Care Trap site compared to the IVM site. Post hoc Tukey's tests used to determine how many and which weeks during the intervention period significantly differed revealed almost 3-fold (325 versus 842 for week 15) to 12-fold (35 versus 445 for week 21) significantly fewer eggs were collected from the In2Care Trap site during 2 wk in both June and July and 1 in August (Fig. 2A; Table S1). There were at least 4-fold significantly fewer mosquito larvae collected from the In2Care Trap site during week 1 in July (235 versus 1044 for week 15) and week 1 in September (0 versus 436 for week 25; Fig. 2B, Table S1). Additionally, due to the significant effect of week-treatment interaction on adults ($P = 0.007$), significantly fewer adults were collected in the In2Care Trap site during week 9 (115 versus 556) and 11 (42 versus 430; Fig. 2C, Table S1).

DISCUSSION

To our knowledge, this is the first published data on the effectiveness of using In2Care Traps to control *Ae. aegypti* in a large-scale field trial, and this study adds to the growing evidence of PPF autodissemination being able to reduce mosquito density at the neighborhood scale (Abad-Franch et al. 2015, 2017, Garcia et al. 2020, Unlu et al. 2020). We demonstrated that In2Care Traps were able to reduce *Ae. aegypti* mosquitoes. Use of the In2Care Traps resulted in 60%, 57%, and 57% fewer eggs, larvae, and adults, respectively, collected from that site compared to the IVM site, though the difference was only statistically significant for eggs and larvae. The lack of significant impact of treatment on adults was most likely due to reduced power of the adult analysis. Eggs and larvae were collected from 20 LBJ in both sites each week of the trial. However, due to a limited number of BGS2 traps available for use in the trial, adults were collected from only 10 BGS2 traps per site, resulting in half as many data points used in the adult analysis. However, significantly fewer adults were documented for 2 wk during the intervention period in the In2Care Trap site due to the statistically significant effect of treatment-week interaction on adults.

Insecticide resistance in the *Ae. aegypti* in the IVM site could be a possible reason for the difference in treatment efficacy observed between the 2 sites. Compared with the susceptible Orlando strain, Estep et al. (2018) found that the *Ae. aegypti* from the IVM and In2Care Trap sites were moderately resistant and highly resistant, respectively, to permethrin. Although permethrin was not used as an adulticide during the trial, cross resistance to multiple pyrethroids like deltamethrin in *Ae. aegypti* is common (Chadwick et al. 1984, Rodríguez et al. 2002, Flores et al. 2013). Additionally, a recent state-wide survey of insecticide resistance in Florida *Ae. aegypti* populations found that 95% and 32% of the populations were resistant to all pyrethroid and organophosphate active ingredients tested, including deltamethrin (Parker et al. 2020).

Our field trial showed that while In2Care Traps were effective at reducing *Ae. aegypti*, their constant deployment over a large area ($\geq$40 ha) was more time consuming (>700 h) than the IVM strategy of source reduction, larviciding, and adulticiding (<200 h). Moreover, because In2Care Trap deployment and maintenance in the In2Care Trap site were conducted on foot, using In2Care traps was more labor intensive than the IVM strategy. However, worldwide, programs like MCMCD that use year-round surveillance and source reduction, as well as ground and aerial larviciding and adulticiding, are in the minority due to the lack financial resources generally available for routine *Aedes* control programs (Horstick et al. 2010). Because using In2Care Traps does not require too much training, controlling *Aedes* mosquitoes using In2Care traps is potentially a viable option for areas without large-scale, sophisticated control programs in place. A simple way to decrease the time and labor spent deploying and maintaining In2Care Traps would be to reduce the size of the treatment site. For example, using In2Care Traps as the only *Aedes* control method at a site <20 ha would require half the time and labor needed in this study's In2Care Trap site. Trap maintenance frequency may also be reduced, particularly in community engagement-based programs where inhabitants could participate in intermediate trap refilling with water. In2Care Trap trials in Cambodia and Laos indicate that maintenance every 2 months may suffice for continuous autodissemination and reduced larval development (S. Marcombe and S. Boyer, personal communication).

While our study adds to the body of literature on *Aedes* operational mosquito control research previously described by Horstick et al. (2010) as being scarce and weak, we compared control impacts only in 2 sites, with no element of randomization, and the duration of the trial was relatively short. As such, more trials with a more robust design will be needed for generalizability of the findings and to confirm impacts on mosquito population levels. Also, because *Aedes*-borne viruses such as dengue are not endemic to Florida (Rey 2014) and no transmission was reported during our study, we were unable to test the effectiveness of either control method at reducing human *Aedes*-borne disease cases. Future studies in disease-endemic settings with appropriate economic analyses would assist to accurately assess the efficacy and cost benefits of In2Care Traps versus IVM at reducing *Aedes* mosquitoes and human *Aedes*-borne disease cases.

Impacts on *Culex* mosquitoes, such as *Cx. quinquefasciatus*, which may use containers as larval habitats, were not quantified in this study, but like Su et al. (2020), our field observations showed that In2Care traps may be attractive oviposition and resting sites for these mosquitoes as well. The possibility of having In2Care Traps available as a tool for reducing *Cx. quinquefasciatus* populations is encouraging, not only because *Cx. quinquefasciatus* is an important vector of West Nile (Molaei et al. 2007), Saint Louis encephalitis (Diaz et al. 2013), and Rift Valley fever (Sang et al. 2010) viruses, as well as the filarial nematode responsible for causing lymphatic filariasis (Khan et al. 2015), but also because, like *Ae. aegypti*, *Cx. quinquefasciatus* populations worldwide have been shown to be resistant to many insecticides (Jones et al. 2012, Richards et al. 2017, Yoshimizu et al. 2020). While the active ingredients in the In2Care trap have already been shown to kill *Culex* larvae and adults separately in prior studies (Ali et al. 1999, Howard et al. 2010), future studies are required to assess the combined impacts of PPF and *B. bassiana* in In2Care Traps on *Culex* mosquito populations.

In our study, *Ae. aegypti* control using In2Care traps alone was more time consuming and labor intensive than MCMCD's IVM strategy. But this study did not assess the impact of In2Care Traps included within an IVM program, and we believe that such a combined approach could be the most effective control strategy for *Ae. aegypti* and *Ae. albopictus*. More research is needed to determine which existing and new mosquito control tools should be combined to result in the most effective IVM program against *Aedes* vectors. We conclude that while using In2Care Traps alone as a mosquito control method for large areas (e.g., >20 ha) may be less practical for control programs with the capacity to conduct ground and aerial larviciding and adulticiding, the PPF dissemination tool may be particularly useful in areas without sophisticated mosquito control programs and in small-sized hotspots or target areas where the higher labor intensity is warranted by the need for continued mosquito suppression and prevention of *Aedes*-borne diseases.

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Supplemental materials

S1 Table. Mosquito surveillance data from In2Care Trap and IVM sites. (XLS)