EVALUATION OF 1-OCTEN-3-OL AND CARBON DIOXIDE AS BLACK FLY (DIPTERA: SIMULIIDAE) ATTRACTANTS IN ARKANSAS[1]

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ABSTRACT. Carbon dioxide and 1-octen-3-ol were evaluated individually and in combination as black fly attractants. Significantly greater numbers of *Cnephia pecuarum* were collected in traps baited with CO_2 and CO_2 + octenol as compared with octenol alone or no bait. While greater numbers of *C. pecuarum* were collected in traps baited with the combination of CO_2 and octenol as opposed to CO_2 alone, results were only significantly different ($P \geq 0.05$) in one test. In contrast, significantly ($P \geq 0.05$) more adults of *Simulium meridionale* were collected in traps baited with CO_2 alone. Octenol alone was not an effective attractant for the black fly species collected in the course of this study. In addition, use of octenol in conjunction with CO_2 may impair representative sampling of black fly species present in a given area.

INTRODUCTION

Carbon dioxide (CO_2) has long been used as an effective attractant to survey black fly populations (Snoddy and Hayes 1966, Shipp 1985, Mason 1986). Recent studies have indicated that 1-octen-3-ol (octenol) is also a suitable attractant for a wide range of biting Diptera including Culicidae (Takken and Kline 1989), Tabanidae (French and Kline 1989) and Glossinidae (Vale and Hall 1985). In addition, the combination of both CO_2 and octenol produces a synergistic response in some mosquito species (Kline et al. 1990a, 1991a). However, no studies have been conducted to determine similar responses of black flies to this attractant.

While CO_2 is effective for black fly surveillance, it also has limitations from an operational point of view. Use of CO_2 as an attractant entails use of either bottled gas or dry ice. While both sources of CO_2 are relatively inexpensive, their use and availability in remote locations can be cumbersome. Therefore, it is appropriate to examine other potential black fly attractants that are economical, readily available and easily transported. The purpose of the present study was to determine the responsiveness of black flies to octenol and CO_2, individually and in combination.

MATERIALS AND METHODS

Tests were conducted in 2 Arkansas counties (Arkansas and Conway) during March 1991 and February 1992. The study site in each county was located near streams known to produce *Cnephia pecuarum* (Riley), the southern buffalo gnat. Testing in Arkansas County was conducted at a site within 100 m of Little LeGrue Bayou. The study site in Conway County was 10 m from Point Remove Creek. Both sampling sites were composed of open fields bordering a tree line (Fig. 1). A tree line trap location was chosen to reduce the impact of wind on adult collection. Adult collections were obtained using 1.8 × 1.8 × 1.2 m canopy traps supported by a 2.2 cm center poles, described by Catts (1970), with an entrance height of 0.6 m above the ground. Traps were spaced at 15.2 m intervals to eliminate treatment interactions. All tests were conducted during peak seasonal occurrence of *C. pecuarum* during both years. Attractants and combinations used in these studies were: 1) no attractant, 2) octenol alone, 3) CO_2 alone, and 4) octenol + CO_2. A Latin square experimental design was used to eliminate differences among rows (days) and columns (trap locations). Treatments were rotated daily to the right so that after 4 days each treatment had been treated through each trap location.

Dry ice was the source of CO_2 in these investigations. Coleman PolyLite® insulated 2 liter

Fig. 1. Tent trap for evaluation of black fly attractants.

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Table 1. Mean collection of *Cnephia pecuarum* and *Simulium meridionale* (±SE) per trap day for different attractants in tent traps in Arkansas and Conway counties, Arkansas.

Species County	Attractant			
	None	Octenol	CO_2	CO_2 + octenol
C. pecuarum				
Arkansas, 1991	51.8 ± 28.7 B*	24.0 ± 9.1 B	505.3 ± 93.3 A	833.5 ± 448.4 A
Arkansas, 1992	72.3 ± 38.2 B	37.5 ± 10.4 B	748.5 ± 15.8 A	739.8 ± 156.1 A
Conway, 1991	18.5 ± 6.3 C	11.3 ± 4.0 C	115.5 ± 34.9 B	346.8 ± 101.7 A
S. meridionale				
Conway, 1991	2.5 ± 1.7 B	1.0 ± 0.4 B	154.3 ± 65.5 A	16.5 ± 11.0 B

* Means, by county and/or date, followed by the same letter are not significantly different ($P > 0.05$).

jugs were packed with 2.7–3.2 kg of dry ice and attached to the center pole of the tent trap at a height of 1.1 m. Visual observation indicated that full opening of the jug spigots (66.3 mm^2) provided a similar constant rate of CO_2 release in all traps with a small amount of dry ice remaining after 24 hours. In addition, dry ice jugs were replaced daily with fresh jugs.

Octenol was dispensed using a wick method similar to that described by Kline et al. (1991a). Each glass vial (20 ml) was provided with 4 ml of octenol and capped with a rubber septum, which was additionally fitted with a small plastic tube of sufficient size to prevent pinching of the wick. Pipe cleaners served as wicks and extended 0.4 cm above the septa. After wick insertion, each vial was inverted until the wick was completely saturated and the vial marked according to octenol level to allow for daily adjustment of the attractant. Octenol vials were attached to the center pole using duct tape at a height of 1.1 m and were placed near the point of CO_2 release when used in combination treatments.

Sampling in each county during 1991 was conducted over 2 wk as a result of inclement weather conditions, i.e., 2 replicates on consecutive days each week. Adult trap sites in Arkansas County remained the same during both weeks. However, due to flooding of the original adult trap site in Conway County, it was necessary to relocate the traps during the second week. Traps during the second week were located on a similar tree line less than 94 m from the original test site. Another black fly species, *Simulium meridionale* (Riley) or turkey gnat, was collected during the second week of testing in Conway County. Two additional replicates (4 total) were conducted at the second site to determine the response of this species to the attractants being investigated. One additional trial was conducted in Arkansas County during February 1992 at the original study site of 1991.

Adults were captured by both aspirating from the inner surfaces of each tent trap, using a electric backpack aspirator, and in collection cages mounted on top of each tent trap at 24 h intervals. Collection cages consisted of 25.4 cm long sections of 10.2 cm diameter polyvinyl-chloride (PVC) pipe. A 10.2 × 20.3 cm cross section was removed from opposite sides of each pipe and covered with fine mesh vinyl window screening. Polyvinyl-chloride pipe collars secured each trap to the top of the tent. The top 5 cm of 3-liter plastic beverage bottles were fitted to the inner lip of each pipe collar at the junction of the cage to serve as an entrance cone. The top of each cage was sealed with 4 mm clear vinyl sheets secured by rubber bands. Assembly of trap components required no adhesive and allowed easy disassembly for removal of captured adults. Collected adults were immediately taken to the laboratory and frozen for later identification.

Data obtained for each attractant and sampling period were transformed, sqrt(n + 1), for statistical analysis. Data were analyzed ($P > 0.05$) using analysis of variance (ANOVA), SAS Institute (1985), to test equal mean densities among treatments. Treatments means were then separated using Duncan's multiple range test (SAS Institute 1985).

RESULTS

Three species of black flies were obtained during the course of these investigations. *Cnephia pecuarum* were collected in traps in both Arkansas and Conway counties, while collection of *S. meridionale* was limited to Conway County. Both species were observed to respond differently to the attractants tested. In addition, a few specimens of *Simulium vittatum* Zett. were collected in Arkansas County during both years but not in sufficient numbers to allow representative statistical analysis.

Cnephia pecuarum was consistently collected in significantly greater numbers in CO_2 and CO_2 + octenol baited traps in both counties (Table 1). While octenol in combination with CO_2 resulted in greater capture of *C. pecuarum* per trap day in Arkansas County during 1991, results were not significant as compared with CO_2

alone. Similarly, no significant difference in attractiveness was noted for CO_2 or CO_2 + octenol in Arkansas County during 1992. In contrast, significantly greater numbers of *C. pecuarum* were collected in the combination treatment in Conway County in 1991. While greater numbers of *C. pecuarum* were collected in unbaited traps as compared with octenol baited traps, these mean collections were not significantly different in either year or county.

Significantly greater numbers of *S. meridionale* were collected in traps baited with CO_2 alone (Table 1). Unlike the results observed for *C. pecuarum*, octenol was ineffective in enhancing collection of *S. meridionale* when tested in combination with CO_2. Furthermore, collection of *S. meridionale* in traps using CO_2 + octenol, octenol alone, and no bait were not significantly different.

DISCUSSION

Octenol alone was not an effective attractant for the black fly species collected in the course of these investigations. However, Takken and Kline (1989) and Kline et al. (1990b, 1991b) have shown that octenol alone is an effective attractant against some mosquito species. Therefore, due to the few black fly species collected during the course of this study, additional investigations are warranted against a broader spectrum of black fly species.

Octenol was shown to enhance the total number of flies collected when used in combination with CO_2, but only when *C. pecuarum* was the target species. A similar effect of the combination of octenol and CO_2 was noted by Kline et al. (1990a, 1991a) for mosquitoes, specifically for *Anopheles* spp., *Mansonia* spp. and *Coquillettidia perturbans* Walker. In contrast, addition of octenol to CO_2 baited traps resulted in a significant reduction in collection of the black fly *S. meridionale*.

The different response observed for these 2 black fly species to octenol may be related to their respective host seeking behavior. Both species respond well to CO_2 as means of locating potential blood meals. As *C. pecuarum* feeds primarily on large animals (bovids and cervids), the addition of octenol may serve as an additional cue to host suitability as this compound is a natural component of bovine respiration. In contrast, *S. meridionale* is primarily a poultry feeder. While CO_2 would initially attract *S. meridionale*, the additional chemical cue, octenol, may in turn signify an unsuitable host.

While our study indicates that octenol alone is not a suitable attractant for *C. pecuarum* and *S. meridionale*, it is not possible to rule out its effectiveness for other black fly species. In addition, the increased collection of *C. pecuarum* observed when using octenol in combination with CO_2 over CO_2 alone, in 2 of 3 tests, indicates that octenol may prove useful in closer population monitoring of this species. However, as there was no statistical difference between the combined use of octenol + CO_2 and CO_2 alone, the increase in cost to add octenol may not be justified. Furthermore, results for *S. meridionale* show that use of octenol may negatively impact collection of concurrently occurring black fly species. As pointed out by Kline et al. (1991a) for mosquitoes, the major black fly species within each geographic region must be identified and targeted with specific techniques. It can be concluded: 1) CO_2 is superior to octenol as an attractant for *C. pecuarum* and *S. meridionale*, 2) octenol use in conjunction with CO_2 may aid in more accurate population monitoring programs for *C. pecuarum*, and 3) octenol use should be limited to species that are known to respond favorably to its enhancing effect with CO_2 and not be used when quantitative cross-sectional sampling of undetermined black fly species is desired.

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