COMPARATIVE EFFECTS OF CO_2 FLOW RATES USING MODIFIED CDC LIGHT TRAPS ON TRAPPING ADULT BLACK FLIES (SIMULIIDAE: DIPTERA) [1]

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ABSTRACT. Seven selected CO_2 flow rates were statistically evaluated using modified CDC traps supplied with CO_2 from a single source. The 500 ml per min (0.1214 lb per hr) flow rate was found to be the optimum for trapping *Cnephia mutata* and *Prosimulium hirtipes*. The operating performance of supplying CO_2 from a single source one 20 lb (net) cylinder via hoses to multiple CDC traps was considered advantageous with respect to ease in selecting specific flow rates, logistics and cost analysis.

Carbon dioxide has been used to collect black flies for many years. Numerous experimenters have evaluated CO_2 as an attractant for black flies using various types of light traps; but, there is little published work analyzing the attractiveness of various CO_2 release rates using valid statistical design. The optimum CO_2 flow rate for attracting black flies has been reported at 1 lb per hr (4.12 liters per min) by Snoddy & Hayes (1966), 2 liters per min (.4857 lb per hr) by Frommer et al. (1974), and 400 ml per min (.0971 lb per hr) by Fallis et al. (1967); however, in these studies, no statistical designs or determinations were reported to validate the findings.

The present study was conducted to analyze statistically selected CO_2 flow rates to determine the optimum CO_2 flow rate for trapping adult black flies. In addition the study was designed to evaluate a method of supplying CO_2 from a single source to multiple operating modified CDC traps.

MATERIALS AND METHODS. The study was conducted daily from 0730 hr to 1400 for 8 days during late May and early June 1975 at Fort Drum, New York. Eight modified CDC traps without light bulbs were fitted with new 2.9v DC motors for use during the study. Four 1.5v flashlight batteries were used per trap as the power source. New motors, which were installed to increase trap suction flow rate performance, were found to have twice the suction (29.2 cfm) compared to the standard CDC Barber-Coleman motors (14.1 cfm). Motors (model F–35c) were purchased from Edmonds Scientific Catalog 752,150 Edscrop Building, Barrington, New Jersey 08007.

All traps used were pretested for equal suction flow rates using an Anemotherm air meter, model 60. The mean flow rate per trap was calculated at 28.2 ± 2.0 ft of air flow per min.

Instead of supplying each trap with a separate CO_2 tank, a single source was used for all eight traps. This consisted of one 20-lb (net) CO_2 cylinder with regulator valve connected by a 3/16-inch bore rubber latex tube to eight interconnected ¼-inch brass T connector valves; eight 50-ft 3/16-inch bore rubber latex tubes led separately from the connector valves to the eight traps (Figure 1). The tubes were clipped under the trap cover plates.

All eight traps were placed 5 ft above

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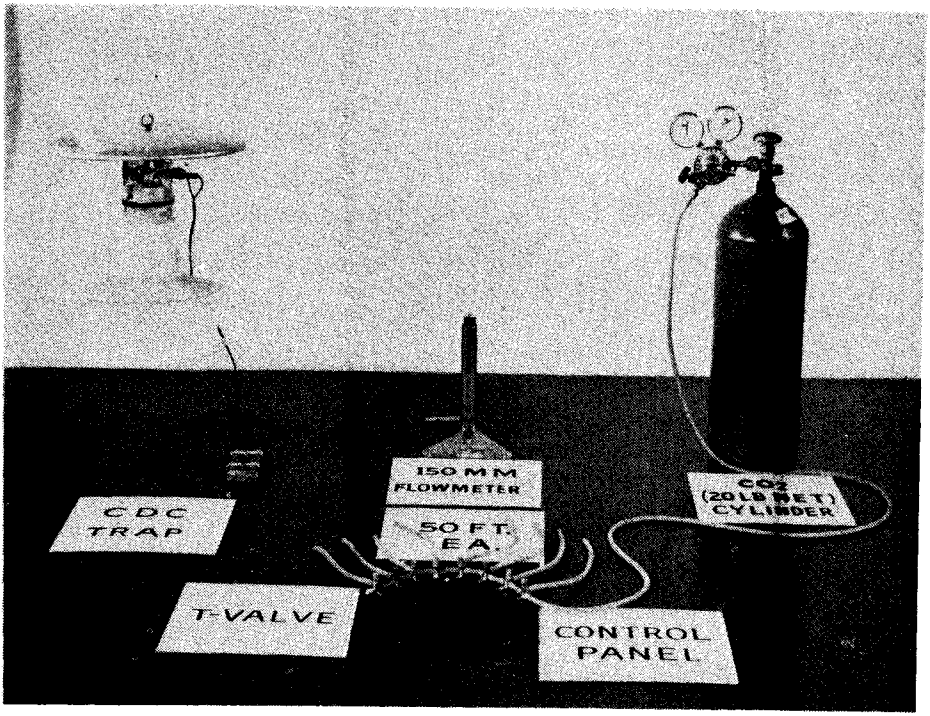

Fig. 1. Apparatus used in evaluating selected CO_2 flow rates in trapping adult black flies.

the ground at random in a 100-ft diameter circle, each approximately 50 ft from the center source of CO_2. The test area consisted of secondary vegetative growth, typical of the local flora.

The following selected CO_2 flow rates were evaluated: 50, 100, 200, 500, 1000, 1500 and 1900 ml of CO_2 per min at 10 psi delivery pressure. A control trap without any CO_2 flow was also operated during each test. Trap flow rates were calibrated at the CO_2 source by making proper valve adjustments using a Matheson Gas Product 150 mm glass flow meter at the beginning and end of each daily test period.

Each CO_2 flow rate was initially assigned at random to the eight traps. Trap flow rates were adjusted daily to ensure that each trap was assigned all seven selected flow rates for a period of 1 day each during the test period. Each trap was also operated for 1 day during the period without CO_2 as a control. This latin square design was used so the variables of trap days, trap locations and selected CO_2 flow rates could be analyzed by use of Duncan's Multiple Range Test. The environmental variables of temperature and wind direction are accounted for by the analysis of trap days and locations respectively. A 10% level of error was chosen in calculating Duncan's Multiple Range Test due to possible fluctuations in each of the CO_2 flow rates.

RESULTS AND DISCUSSION. During testing a total of 4808 adult black flies were collected from all eight traps. The species involved were *Cnephia mutata* comprising approximately 46% of the total and the *Prosimulium hirtipes* complex making the remaining 54%. These species and percentages were determined by the identification of 1234 larval specimens collected in the study site 1 week prior to testing.

An average flow rate increase of 10% was found to occur within each of the seven CO_2 flow rates evaluated. Such fluctuations were anticipated since external temperature can affect both tank and regulator valve setting. The optimum flow rate was difficult to determine since an overlap in the size of trap catches occurred with the various flow rates; however, in this study as little as 500 ml of CO_2 per min (.1214 lb per hr) was found to be sufficient for trapping black flies. A daily mean of 116.88 specimens was collected at this flow rate. Flow rates above 500 ml of CO_2 would waste CO_2 and would not ensure increased trap collecting efficiency. Flow rates below 500 ml of CO_2 occasionally might equal trap results of 500 ml, but on a statistical average would result in fewer specimens trapped (Table 1). The 1 lb of CO_2 per hr that Snoddy and Hayes (1966) reported as the optimum flow rate would be equivalent to 4117 ml of CO_2 per min, which is eight times the optimum delivery rate reported in this study.

The average temperature during the study was 73.2°F ±3.0°F and the relative humidity was 64% ±10%. Finally, in monitoring adult black fly activity, trap locations in the selected test site appear to have little effect on the number of specimens collected as shown in Table 1.

Supplying CO_2 from a single source to multiple traps as shown in Figure 1 can be accomplished with considerable ease and accuracy, since all trap flow rates are calibrated at the T-valves and not at the traps. Additionally, this system offers significant savings, since multiple traps can be supplied with varying CO_2 flow rates from a single CO_2 cylinder. The cost of a single 20 lb empty CO_2 cylinder and regulator is approximately $100.00, and the cost of CO_2 is estimated at $6.00 per refill. It was necessary to refill the cylinder every other day since a total flow rate of 5250 ml of CO_2 per min was utilized during testing. A disadvantage of this technique is the requirement of large amounts of tubing if multiple traps are to be operated.

Table 1. Comparison of trap CO_2, flow rates, trap days and trap locations using Duncan's Multiple Range Test.*

Co_2 flow rates in ml/min	0	50	100	200	500	1000	1500	1900
Means**	0.1	24.3	37.8	31.5	116.9	106.8	130.0	153.3
Relationships***	d	cd	bcd	cd	ab	abc	ab	a
Trap days	#1	#2	#3	#4	#5	#6	#7	#8
Means**	203.5	185.0	121.3	33.8	18.0	15.0	12.9	11.5
Relationships***	a	a	ab	b	b	b	b	b
Trap locations	#1	#2	#3	#4	#5	#6	#7	#8
Means**	45.9	76.0	107.0	78.1	65.3	80.3	66.1	81.9
Relationships***	a	a	a	a	a	a	a	a

* 10% level of error.
** Mean number of adult black flies trapped per flow rate, day and location respectively.
*** Means accompanied by the same letter designation are statistically similar.

Days 1 and 2 differ significantly from days 4–8 (Table 1). Light rain occurred throughout the last 4 days of testing, thus reducing adult black fly activity and contributing to this difference. Wind was light and variable (0–10 mph) throughout the study; however, since traps and flow rates were rotated it was assumed that this variable had little influence on the results.

In summary, using the method and design described, adult black flies can be monitored in a small area with logistical ease and accuracy.

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