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A CONSTANT-RATE LIQUID DISPENSER FOR USE IN BLACKFLY LARVICIDING[1]

F. J. H. FREDEEN

Research Station, Canada Department of Agriculture,
University Campus, Saskatoon, Saskatchewan, Canada

Treatment of a stream or river with blackfly larvicide requires injection of the chemical at a constant rate. Notwithstanding the need for uniform injection rates during treatments of test plots, uneven rates can also subject non-target organisms to unnecessary pressures.

Various means of achieving constant injection rates have been used, one of the most sophisticated being that described by Hocking (1950). In his larvicide dispenser, liquid pressures on both sides of an adjustable orifice plate were visible in manometers. With the aid of calibration charts any desired discharge rate could be achieved by inserting a suitable orifice plate and then adjusting valves on both sides of the plate until the required pressure differential was achieved. To maintain a steady discharge rate, however, continued valve adjustments were required as the head of concentrate in the supply tank fell.

A dispenser that I have used on numerous occasions utilizes an air inlet tube to maintain a constant head of liquid above the outlet orifice and thus obviates the need for continuing valve adjustments to compensate for a declining head of liquid in the reservoir (Figs. 1 and 2).

In small plot tests of larvicides in the St. Lawrence River (Fredeen, 1969) a 25-litre polyethylene carboy was used as a reservoir for the larvicide (Fig. 1). The top was fitted with an airtight rubber stopper through which a single, copper air-inlet tube was inserted so that the lower end rested on the bottom of the carboy. This copper tube had an inside diameter of approximately 3 mm and was open at both ends. It was curved about 100° at the bottom end so that the inflow of air was not impeded by contact with the bottom. A spigot at the rim of the bottom of the carboy drained through a 15 cm length of rubber tubing into an open funnel connected to a second piece of tubing that was anchored to the river bed.

The rate of discharge from the carboy was adjusted to 500 ml per minute, either

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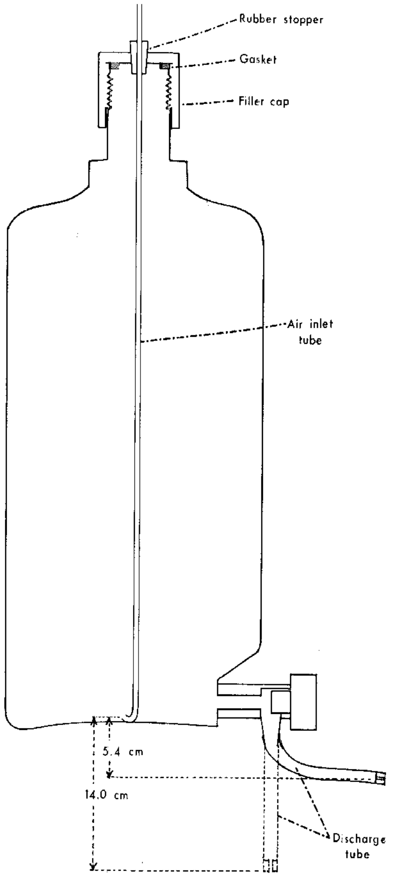

FIG. 1.—Cross-section of a 25-litre carboy fitted for constant-rate drainage.

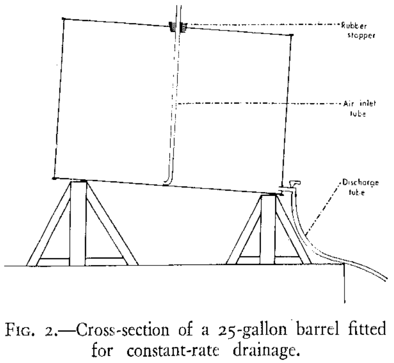

FIG. 2.—Cross-section of a 25-gallon barrel fitted for constant-rate drainage.

by inserting into the 15-cm tube a plug with a hole about 3 mm in diameter drilled through it, or by partly closing the tube with a screw clamp. Without further adjustments the discharge rate remained constant throughout the emptying of the carboy.

Different treatment dosages in the river were achieved by varying the concentrations of larvicide in the carboy. However, the duration of each injection was never varied from 30 minutes. Thus when the appropriate quantity of emulsifiable concentrate had been measured into the carboy, sufficient river water was added to bring the liquid level up to a 15,000-ml line. The top of the liquid could be seen through the semi-transparent walls of the carboy. The rubber stopper with the air-inlet tube was then snugly inserted, the contents thoroughly mixed, the carboy set on a horizontal platform (suspended from a tripod), and the air inlet tube rechecked to ensure that it reached the bottom. Discharge was commenced simply by removing a pinch clamp from the discharge tube.

Tests showed that a wide range of constant-flow discharge rates could be produced by altering the discharge tube but not the air-inlet tube (Table 1). For these tests, conducted in the laboratory, the air-inlet tube was of glass, with a 3-mm inside diameter reduced at the bottom end to 1.5 mm. However, for use in field tests the glass tube was replaced by one of copper.

In these laboratory tests the 25-litre carboy was completely filled with tap water, unlike the field tests where only 15 litres were used. When full, the depth of water above the discharge orifice was about 50 cm. It is obvious that if the head of water, varying from 50 to 0 cm, was not controlled, the discharge rate would be affected not only by the changes in pressure but also by velocity-related friction changes in the discharge tube. However, insertion of the air-inlet tube reduced the effective head to a minimum value that remained constant throughout

TABLE 1.—Rates of discharge of tap water from a 25-litre carboy (Fig. 1) with an air inlet tube 3.0 mm in inside diameter, restricted to 1.5 mm at its bottom end, and with four different discharge orifices and/or discharge tube positions

Inside diameter of discharge orifice (mm)	2.9	2.9	8.0	8.0
Vertical distance between the bottom ends of the discharge orifice and air inlet (mm)	54	140	54	140
Total time required to empty carboy (min)	90	59	26	14
Average discharge rate during emptying of top half of the carboy (ml/min) [1]	277	434	1003	1875
Average discharge rate during emptying of bottom half of the carboy (ml/min) [1]	277	428	952	1765
Discharge rate during first minute of discharge (ml/min)	295	470	1090	1990
Discharge rate during second minute of discharge (ml/min)	273	425	1080	1920
Discharge rate during penultimate minute of discharge (ml/min)	180	434	730	1710
Discharge rate during final minute of discharge (ml/min)	29	178	90	30

[1] Excluding final one minute of discharge.

any decline in the head of liquid in the reservoir. Relatively constant discharge rates were thus achieved and these rates could be altered by adjusting the vertical distance between the bottom orifice of the air-inlet tube and the external orifice of the liquid discharge tube. Uniform performance between tests thus required insertion of the air inlet tube to the same depth each time, maintenance of the dispenser (i.e., the relative positions of the two orifices) in a uniformly horizontal position, and control of the position of the discharge tube. In various discharge tests we altered the constant flow rate from 277 to about 1830 ml per minute merely by adjusting the position of the discharge tube and/or altering its inside diameter (Table 1). Deviations from average discharges occurred during the first minute of discharge or until air commenced to flow down the air-inlet tube, and also during the final 1 or 2 minutes of flow when the level of water in the carboy reached the outlet orifice.

The inside diameter of the air-inlet tube could be enlarged somewhat without affecting the rate of water discharge. However, when its diameter was too large, relative to the rate of discharge, the inflow of air became insufficient to prevent water from resurging into the bottom end. This caused irregular interruptions in the rate of air inflow. Alternatively when the air inlet was reduced to the point where it restricted the inflow of air, the uniformity of the discharge rate was also affected. The data in Table 1 show that for the largest discharge rates, the capacity of the air inlet tube was inadequate as indicated by the slight declines in discharge rates between the top and bottom halves of the carboy.

Variations in the depth of insertion of the air-inlet tube also caused variations in the discharge rates. Raising the air-inlet tip 4 mm from the bottom of the carboy increased the rate of water discharge by about 25 percent. Thus it was important to ensure that the tip was always inserted to the same depth, i.e., touching the bottom. Even with care, discharge rates could not be duplicated precisely, perhaps mainly because the carboy was not completely rigid. One could improve reproducibility by using a rigid container and by adjusting the air inlet depth and its inside diameter, and the water outlet position and its inside diameter with metering screws. However, for my purposes the simpler construction was adequate since the rate of discharge could be quickly measured and the volume to be discharged adjusted accordingly.

I have also used this system to drain 25-gallon barrels of larvicide (Fig. 2) at a constant rate. The following adjustments were required to achieve drainage in 16 minutes. A bung on the edge of the barrel top was replaced by a nipple and a 50 cm length of Tygon tubing with an inside diameter of 1.6 cm. Then the barrel was tipped onto its side into drainage position and in doing so the end of the open hose was tied up, high enough so that it could become partly filled with larvicide and yet not commence drainage. Then a side bung was replaced snugly with a one-holed rubber stopper into which a copper air-inlet tube with an inside diameter of 1.1 cm was inserted. The tube was pushed downwards until it touched the opposite side of the barrel and then withdrawn 1 cm so that the inflow of air would not be impeded. Alternatively the bottom end could have been recurved about 100°.

The discharge of larvicide was commenced by cutting the tie string so that the discharge tube swung downwards, effecting a sudden commencement of discharge. This caused air to be sucked quickly down the air-inlet tube, allowing a steady discharge rate within a few seconds. The use of this discharge tube also allowed an operator to put more of these units into operation per minute than if a tap had to be turned on each one. Additionally premature overflow, resulting from expansion of the contents while sitting in the sun, spilled from the discharge tube rather than from the air-inlet tube.

In review the advantages of the system are:

1. A constant discharge rate is maintained throughout the emptying of the reservoir without the need for continuous adjustments to compensate for a declining head of liquid.

2. The applicator is simple and sturdy, and may be quickly recalibrated in the field by measuring the discharge rate. Then, for example, if a 30-minute application is required, the volume of mixture used must be 30 times this 1-minute discharge volume.

3. The applicator is completely drained each time it is used. Thus it can be easily transferred from one location to another.

4. If an emulsifiable concentrate of larvicide is used, water for dilution purposes can be obtained at each site. This logistical advantage is lost, however, if an oil solution is used and water cannot be used as a diluent.

5. Almost any airtight container may be adapted for use, provided it has openings for the air-inlet tube on the top and the discharge valve at the bottom.

A major disadvantage was the vulnerability of the applicator to high winds blowing across the air-inlet tube. On one occasion 20 to 30 m.p.h. winds were sufficient to interfere with the inflow of air, causing reductions in discharge rates of about 50 percent.

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