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A DEVICE FOR THE DRIP APPLICATION OF INSECTICIDE CONCENTRATES

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Introduction. The drip method of applying insecticides to flowing and impounded waters for mosquito control has been used intermittently for the past 20 years. Numerous methods have been used to introduce chemical insecticides in both the concentrate and dilute form. With the development of organophosphate compounds with improved stability, renewed attention has been given to the use of the drip technique employing insecticide concentrates.

Knowles and Fisk (1945) employed a pump to transfer water into an air-tight bottle connected to a sealed reservoir containing the insecticide solution. With an increase in air pressure in the reservoir, the larvicide was discharged via a tube. Wisecup *et al.*, (1946) described a drip can regulated by a metering valve from an oil stove. Geib and Smith (1949) employed the siphon principle to discharge a dilute DDT solution from a 50-gallon drum reservoir, via a glass metering tip. Lancaster, (1964, 1965) used the same principle to apply emulsifiable concentrates through hypodermic needles for mosquito control in rice fields. Gahan *et al.*, (1955) designed an applicator for dispensing dilute insecticides which had a constant head column fed by gravity flow. The height of the liquid column was regulated by the liquid level in the well; when the level decreased, air flowed into the sealed reservoir breaking the vacuum and filling the column enough to cover the lateral opening. When the air supply was cut off, a vacuum formed again and the flow ceased.

Recently Mulla and Darwazeh (1968), and Sjogren and Mulla (1968), employed a constant head applicator which used calibrated discs to vary the discharge rates desired. In using this apparatus to dispense emulsifiable concentrates, problems were encountered by the senior author due to the inability to precisely adjust the discharge rate to that desired and the tendency of the orifice to clog when using commercially available formulations.

The device described in this paper was designed for simplicity, portability, accuracy of discharge and ease in the regula-

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tion of the discharge of emulsifiable concentrate solutions.

METHODS AND MATERIALS. The basic design used in this applicator follows closely that reported by Gahan *et al.*, for dispensing dilute insecticidal solutions. The reservoir can was constructed with the bottom bowed out to permit complete discharge of its contents. The ¾-inch pipe thread outlet was reduced to ⅜-inch using an elbow. This was connected to a brass gate valve at a point 2½ inches below the top of the 1-inch I.D. insecticide well. Two inches below the top of the well, a ⅜-inch overflow drain line connected to a small reservoir attached to one of the legs of the tripod stand. At the bottom of the 5½-inch long well a 50 mesh screen was placed prior to connecting to a ⅜-inch leak-proof swivel joint.[4] To prevent deterioration in the packing of the swivel joint, a Teflon packing was employed. A 5-inch length of ¼-inch pipe was attached to the swivel joint using an elbow reducer. A hypodermic syringe Luer-Lok attachment was affixed to the lower end of the arm to facilitate exchange of the standard hypodermic needles employed to regulate the discharge. The tips of the needles were dulled to reduce the chance of accidental skin puncture. The inside diameter of standard gauge needles was determined from factory specifications. These may be seen in Table 1, for the needles 28 thru 13 gauge.

DISCUSSION. Tests were conducted to determine the discharge rates which could be obtained with the above described applicator. A complete range of discharge rates was attained using the needle sizes 28 thru 13. By rotation of the arm from the horizontal to the vertical position, a variation in the head is achieved, thus discharging different rates for each needle attached to the end of the arm. The needles may be changed without discharge of insecticide by rotation of the arm dorsally to a point above where the reservoir

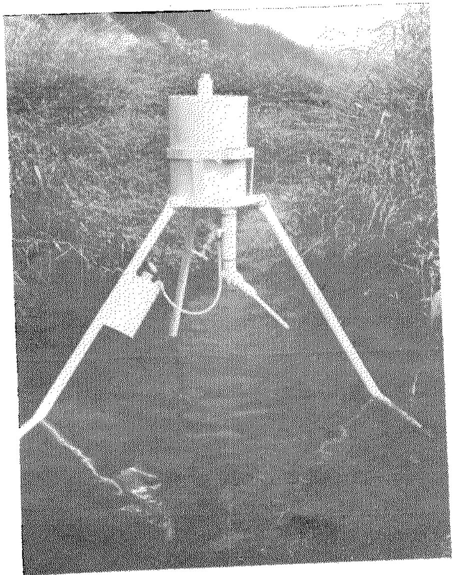

FIG. 1.—Drip applicator with tripod stand in operation in an overgrown irrigation ditch.

discharges into the well. Figure 1 illustrates the applicator with tripod stand in operation under field conditions. The discharge rates obtained for each needle at the three positions using water, Abate 4 EC and Baytex 4 EC, are presented in Tables 1 thru 3.

To determine if crystallization problems would arise at the orifice due to the evaporation of the solvent, Baytex EC was dripped at the rate of 3 ml. per minute over a 24-hour period (70° F ± 10) on several occasions. Readings taken at the same temperature at the beginning and at the end of each 24-hour period showed the average discharge rate varied less than 0.2 milliliter per minute.

In tests to determine the discharge rates for emulsifiable concentrates of different concentrations and viscosities, once the rate of discharge for a given needle at a given arm position was determined, the only

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TABLE 1.—Rate of water flow in milliliters per minute through a range of needle sizes at three arm positions (2 ml. of X-45 added/gallon). Test temperature 70° F. ± 10.

Needle Gauge	Inside Dia. (mm.)	Arm Position Horizontal	45° Angle	Vertical
28	.18	.1	.2	.4
27	.20	.4	1.0	1.1
25	.24	.5	1.6	1.8
24	.29	1.2	2.2	2.2
23	.32	1.8	3.7	3.9
22	.39	2.4	4.8	5.2
21	.50	4.2	8.1	9.3
20	.58	7.5	16.0	16.7
19	.69	10.5	20.7	21.5
18	.84	18.5	37.0	40.5
17	1.04	33.0	66.2	69.0
15	1.37	44.0	97.0	103.8
13	1.80	76.0	224.0	245.0

TABLE 2.—Rate of flow in milliliters per minute with Abate 4 EC through a range of needle sizes at three arm positions. Test temperature 70° F. ± 2.

Needle Gauge	Inside Dia. (mm.)	Arm Position Horizontal	45° Angle	Vertical
22	.39	....	0.1	0.2
21	.50	0.2	0.4	0.5
20	.58	0.5	0.9	1.1
19	.69	0.6	1.3	1.6
18	.84	1.2	2.7	3.3
17	1.04	2.4	5.6	6.8
15	1.37	5.3	14.5	16.2
13	1.80	11.0	37.0	42.0

TABLE 3.—Rate of Baytex 4EC flow in milliliters per minute through a range of needle sizes at three arm positions. Test temperature 70° F. ± 2.

Needle Gauge	Inside Dia. (mm.)	Arm Position Horizontal	45° Angle	Vertical
27	.20	0.1	0.2	0.2
25	.24	0.3	0.3	0.4
24	.29	0.4	0.7	0.8
23	.32	0.6	1.4	1.6
22	.39	0.8	1.8	2.0
21	.50	1.2	2.5	3.4
20	.58	1.3	5.9	7.0
19	.69	4.0	8.8	10.0
18	.84	6.5	16.3	18.0
17	1.04	15.5	31.0	37.0
15	1.37	33.0	66.0	78.0

variable which appeared to influence the rate of discharge was temperature altering the viscosity of the concentrates. In several cases involving low flow rates a 10° F. change in temperature caused as much as one-fourth total change in discharge rate. The overflow drain was installed to drain excess fluid occasionally forced into the well by increased air pressure within the reservoir. When low flow rates did not remove sufficient fluid from the reservoir to compensate for air expansion during warming, the vacuum weakened permitting the discharge of additional fluid. Once the applicator warmed to the ambient temperature, air expansion decreased and the vacuum held. To minimize this effect, the apparatus was painted white. In preliminary field experiments this appeared to reduce the variability due to temperature, however, an insulated box or sun shield would be justified for field use in areas of widely varying temperatures.

The materials needed to assemble the applicator were purchased at the time of construction for less than $50.00. The major expense involved was the Teflon-packed swivel joint.

SUMMARY. The design and functional value of a constant head applicator for dispensing insecticide concentrate is described. Fluids of various viscosities can be discharged accurately over a wide range of rates by selection of the appropriate needle size and by placing the movable arm in the proper position. The discharge rates of water and two insecticide concentrates are presented for comparison. The simplicity, portability, and accuracy in rate of discharge over a wide range, provide an indication of the potential value of this design for the drip application of insecticide concentrates.

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