THE USE AND APPLICATION OF GRANULAR LARVICIDES WITH A COMPRESSED AIR GUN

JACK H. KIMBALL
Manager, Orange County Mosquito Abatement District, Santa Ana, California

INTRODUCTION. Granular larvicides and new equipment for dispensing granules are helping the Orange County Mosquito Abatement District keep pace with the fastest growing county in the United States. Artificial breeding sources for mosquitoes as well as for other aquatic insect pests have been created as fast as agricultural operations, salt marsh areas and other natural breeding sources have disappeared. Our present and future control program, therefore, is designed for the many small breeding sources inherent to urban and suburban communities in Southern California where the climatic conditions are optimum for year-round outdoor living as well as for year-round mosquito production.

The application of granular larvicides with a compressed air gun has been developed by the Orange County Mosquito Abatement District to treat mosquito breeding sources created by the drainage of excess irrigation water from residential areas and from agricultural operations. These sources are separated into two types which must be treated at routine intervals of from 7 to 14 days during our six-month summer season, May through October, and less frequently during most of the winter season. The District has 26 domestic drainage treatment routes covering some 220 square miles of residential area within which all street gutters, catch basins, roadside ditches and culverts that are chronic breeding sources are systematically treated. The other source type consists of the 45 flood channels totaling some 122 miles in length which are designed to carry anticipated flood flows to the Pacific Ocean through the 24 incorporated cities and a total county population of over 800,000 persons. Since most of these channels are not paved and have minimum grades, the summertim flow (seldom more than two inches i depth) creates ideal mosquito breedin conditions in spite of the outstandin maintenance program by our Oran County Flood Control District. By writte agreement, the Mosquito Abatement Di trict carries out all mosquito control ope ations within the flood channels and th Flood Control District designs, construc and maintains these channels to prevei unnecessary mosquito breeding sourc and conditions.

We have satisfied ourselves that the u of selected types of granular insecticide efficiently applied to these particular typ of mosquito breeding sources, will produ the desired degree of mosquito contr most effectively and economically. Th purpose of this paper is to present th design details of the equipment we ha developed to apply granular larvicide The main elements of this equipment a the granule gun, the automatic compress air supply and the vehicle.

EQUIPMENT USED TO APPLY GRA ULES. Granular materials for mosqui control were being used in the Unit States prior to 1954 (Vannote, 1954 a Washburn, 1954). During the 1953 seaso granular larvicides were successfully a plied by hand to small breeding sources the Salt Lake City District (Re Edmunds & Nielsen, 1953). The she distribution of granules by an Anders twin-rotor broadcaster was used in s treatment for control of *Hippelates* e gnats in a Coachella Valley date gard (Mulla & Barnes, 1958). In Wiscons a rapid method for treating water ar from a boat with low dosages of granul insecticides was developed. Water w pumped from the lake through a Vent which sucked the granules into the strea

which was sprayed onto the surface of the ake (Hilsenhoff, 1960). In California, a and-operated alfalfa seeder was exten-ively used by the Madera Mosquito Abate-nent District (Auguston, 1960) and a orn seeder was successfully developed and sed by the Consolidated District (Raley, 961). The Kern Mosquito Abatement District also reported the successful ap-lication of granules by both the rotary nd horn type seeder (Geib, 1961). The se of compressed air to apply granules as developed by the Consolidated Mos-uito Abatement District (Raley, 1961). his homemade "Granule Shooter" em-loyed the principle of the Venturi to suck ard core granules from a container into ne air stream for ejection to distances up 40 feet. The Orange County Mosquito batement District improved this method y adapting a standard sandblasting gun produce uniform rates of application Kimball & Thompson, 1962).

DESCRIPTION OF GRANULE GUN. The anule gun is assembled from readily ailable commercial equipment costing proximately $100, not including the mpressed air supply. A standard sand-last gun has been adapted to suck the anules from a simple container and to ect them at any desired uniform rate of scharge. For each type and size of anule the rate of discharge is determined the following four factors: (1) air essure; (2) gun air jet diameter; (3) zzle diameter; and (4) length of suction se. The maximum effective throw from e gun is approximately forty feet for 15 esh sand core granules. The actual row varies with the volume of air re-ased by the gun which is controlled by e jet size and the air pressure at the jet. A Kelco Model G790C Sandblast Gun uipped with 1/16" Tungsten Carbide ozzles has proved a reliable and trouble-ee metering device for granules of many pes and sizes. The maximum rate of air pply to meet our field conditions was und to be 5.8 c.f.m. of free air livered at 70 pounds per square inch. ny desired length of ¼" one braid air hose is used to supply the gun in order to permit treatment of breeding sources at any distance from the vehicle. The granules are fed to the gun through a short suction hose (¼" i.d. windshield wiper hose) from a lightweight portable container. A standard two-gallon gasoline can with 5/16" i.d. brass tube extending to the bottom and soldered in place serves as a convenient portable container with a capacity of twenty pounds of 15-mesh granules.

CALIBRATION OF GRANULE GUN. We have used the 15-mesh sand core granule produced by Durham Chemical Company to calibrate our gun. These granules produce very little dust as they pass through the ejector and are heavy enough to travel forty feet against a moderate breeze. Table 1 presents the rate of granule discharge in pounds per minute and the effective throw in feet for each air jet nozzle combination with air pressures at 30, 50, and 70 pounds using a short suction hose three feet long and a long suction hose of twelve feet.

AUTOMATIC COMPRESSED AIR SUPPLY. For maximum discharge and throw of granules, a minimum of 5.8 c.f.m. of free air delivered at 70 psi is required. Our conventional compressor and air reservoir tank used for liquid spraying was not adequate for sustained operation of the granule gun for treatment of large flood channels. The following air compressor was found to meet our requirements: Quincy Model 8X, two cylinder, single stage with running unloader and 8.0 c.f.m. displacement at 800 r.p.m. For trouble-free and efficient field operations we mounted the compressor under the hood for direct drive off the vehicle engine. To prevent excessive r.p.m.'s a 7" magnetic clutch manufactured by Electro Lock, Inc. was installed. A minimum amount of machine work on the compressor housing was required. This clutch is similar to the electric clutch used by the Jefferson County Mosquito Abatement District here in Texas for uncoupling their Buffalo turbines (Thompson, 1961).

TABLE 1.—Rates of Discharge and Effective Throw Using 15-Mesh Sand Core Granules Orange County Compressed Air Granule Gun

Air jet diameter	1/16" air jet		3/32" air jet	
Nozzle size number	No. 3	No. 4	No. 3	No. 4
Effective throw from gun				
30 lb. pressure at jet	20 ft.	20 ft.	30 ft.	30 ft.
50 lb. " " "	25 ft.	25 ft.	40 ft.	40 ft.
70 lb. " " "	30 ft.	30 ft.	..	..
Rate of discharge o lbs./min. long suction hose (12 feet)				
30 lb. pressure at jet	0.61	0.73	0.93	1.25
50 lb. " " "	1.18	1.17	1.30	1.78
70 lb. " " "	1.34	1.55	..	..
Rate of discharge—lbs./min. short suction hose (3 feet)				
30 lb. pressure at jet	1.30	1.66	1.44	2.25
50 lb. " " "	1.57	2.39	1.72	2.88
70 lb. " " "	1.90	2.86	..	..

Although our installation was relatively inexpensive and operated very satisfactorily, it was still subject to failure if the operator neglected to throw the switch when driving at higher speeds between jobs. To overcome this potential weakness and to eliminate custom machine work we are now using a Bendix-Westinghouse TU-Flo 500 water-cooled air compressor. This unit is designed for continuous operation. It produces our minimum air requirements and is installed under the hood of our Jeep Dispatchers by making only two physical changes. The compressor is mounted on the existing battery bracket after the battery is relocated under the driver's seat. The second change requires the addition of a duplicate Jeep fan pulley to the existing fan pulley by a simple operation.

ALL PURPOSE MOSQUITO CONTROL VEHICLE. The Willys DJ3A Jeep Dispatcher with automatic transmission and right-hand drive has been selected as the ideal vehicle for one-man larviciding of street gutters, catch basins, culverts and roadside ditches in the urban and suburban areas of Orange County. Four-wheel-drive Willys CJ2A Jeeps with similar spray equipment are used for the large flood channels and for off-the-road breeding sources.

The increasing traffic hazard to the operator has been an important factor in the selection of this vehicle and its equi ment. The right-hand drive permits t operator to be close to his work witho driving against the traffic flow. T automatic transmission eliminates the co stant changing of gears for the freque stops and slow speeds required for tre ment of roadside sources. The operat can keep one hand on the wheel at times while he sprays with the other han The complete lack of noise from t automatic air compressor permits t operator to hear traffic, an extra drivi safety factor.

Convenience of the equipment for t operator is emphasized. The spray gu for applying either granules or liqu insecticides are located within arm's rea of the operator to encourage a maximum spray time and a minimum of lost ti as well as operator initiative. The granu gun and a coil of light air hose is hu on the front side of the cab and the supp of granules in a two gallon container located on the fender step. The coil a the container can be picked up quick whenever the operator must leave the Je to treat a breeding source that can't reached from the vehicle. Similarly, t liquid spray gun is mounted on the si of the Jeep just below the operator and t coil of spray hose is hung on the rear the pressure tank.

A small supply of oil insecticide unc

TABLE 2.—Field guide for mosquito control operators: Distribution of 15 Mesh Sand Core Granules Using Orange County Compressed Air Granule Gun for 10 lb./acre Application Rate

Job requirements				Granule gun factors				
Swath width	Max. throw	Travel speed	Gun discharge rate for required treatment	Air pressure	Jet size	Nozzle size	Suction hose	Actual gun discharge rate
Ft.	Ft.	MPH	lb./min.	psi	in.	No.	Ft.	lb./min.
By moving vehicle								
5	15	5	0.5	30	1/16	No. 3	12	0.61
10	20	5	1.0	50	1/16	No. 4	12	1.17
20	30	5	2.0	70	1/16	No. 3	3	1.98
30	40	5	3.0	50	3/32	No. 4	3	2.88
By walking								
5	15	..	0.2	use horn seeder				
10	20	2	0.4	30	1/16	No. 3	12	0.61
20	30	2	0.8	30	1/16	No. 4	12	0.73
30	40	2	1.2	50	3/32	No. 3	12	1.30
40	40	2	1.6	50	3/32	No. 3	3	1.72

onstant air pressure of 100 lbs. in a 40 allon tank is standard equipment for hese all purpose vehicles. It is recognized hat granular larvicides will not kill pupae nd that the oil insecticide will be needed n special occasions. Since our 26 domestic rainage routes are scheduled by the Dis- ict Entomologist for treatment prior to ie development of the pupal state (every ven days during the summer months), ie use of oil is limited to new sources and occasions when our treatment cycle is ehind schedule.

FIELD OPERATING PROCEDURES. The ranule gun has been used very effectively r many breeding source problems, in- uding preflood treatment of duck ponds. lowever, our purpose in perfecting this uipment was to increase the effectiveness id the efficiency of our routine treatment street drainage and flood channels rough the use of granular larvicides. andard treatment during the 1961 ason was the application of 5 percent alathion sand core granules at the rate ten pounds per acre for a dosage rate 0.5 lb. of malathion per acre.

Since each breeding source is physically fferent in size, shape and distance from moving vehicle, it is necessary for the osquito control operator to determine e granule gun discharge rate that will produce the required treatment. To do this, the operator must first determine the swath width to be treated, the speed of travel, either on foot or in a vehicle and the maximum throw to give uniform distribution of granules over the breeding source. With these three job requirements determined, he refers to Table 2, "Field Guide for Mosquito Control Operator," to select the granule gun factors that will produce the gun discharge rate for the required treatment of that particular job. Table 2 presents a selected list of typical job requirements in Orange County.

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AGENCIES FOR THE SUPPORT OF RESEARCH IN MOSQUITO CONTROL

RUSSELL W. GIES

Chairman, Interstate Technical Committee on Mosquito Control, Delaware Valley Council, Media, I

As the country has been gradually changing over from a predominantly rural environment to a city and suburban one, the technical problems of mosquito control have in many cases been changing also. But the problems to be met have not been the same in all states, nor have they changed equally in all states. Nearly everyone would benefit by more research in mosquito control, especially the following groups:

1. Mosquito Control Commissions and Health Departments which are now carrying on, or may in the future take up mosquito control work. Benefit to them would come through improved techniques and greater knowledge.

2. The important pest control industry and the insecticide manufacturers industry would benefit through improved methods, techniques, and information, and testing of insecticides, including data on the current local status of resistance of mosquitoes to insecticides. Mining interests would benefit through greater knowledge and better methods of mosquito control on mine property, where breeding is sometimes a real problem.

3. The great army of picnickers, cam ers, boaters, and outdoor clubs would be efit through information resulting in bett individual protection from the annoyan of mosquito bites and other insect nu sances. The hundreds of thousands home owners, farmers, members of gard clubs, and community groups would be efit in the same way, as would the fish men in the states who would welcon more freedom from mosquitoes and biti gnats.

4. The conservation and wild li groups in the states as well as the Sta Departments of Forests and Parks, a interested in studies on the biology a control of pest insects in relation to t very active programs for stream polluti control and clean waters. It is recogniz that certain types of pollution may great increase the breeding of some of the m common pest mosquitoes.

5. The real estate operators and ho builders associations, recreation depa ments, camp operators, and Chambers Commerce would all benefit through i proved control methods resulting in red tion of insects affecting comfort a