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SOME ERRORS INHERENT IN U. L. V. OPERATIONS

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Several errors inherent in spraying operations are magnified as application rates become smaller per unit area. The most common errors result from faulty measurement of the pesticide during application. The apparent lack of appreciation of the problem should be of concern.

As the volume of solution to be applied per unit area decreases, the percentage of the active agent in the spray solution necessarily becomes greater. The lesser the amount being applied per unit area, the greater becomes the probability of an error in measurement (Thompson, 1970a). Errors increase as the emission rate decreases when equipment is used in actual field operations.

The difficulty involved in measuring the flow rate of a viscous liquid, whose temperature is changing, is of considerable magnitude (Tate, 1968). The flow rate does not vary as a smooth curve function. The curve representing the rate of flow against temperature is basically a hyperbola. The hyperbolic curve will be interrupted by a plateau (Ford and Furmidge 1969) caused by the flow-rate remainin constant throughout a range of temperatures. This plateau, if it occurs withi operational limits, can be useful as equipment can be designed to operate withi a flow-rate plateau. A range of severa degrees of temperature within which t operate would allow comparatively crud controls to keep the pesticide solutio within that range. Should the platea extend over only 1 or 2 degrees, or n plateau be available, a small temperatur change can, and will, significantly chang the emission rate of the pesticide solution

An error will occur, even with a flo meter monitoring the rate of flow, unles the temperature of the solution is maintained at the point at which the calibration was made. We have observed tha a change of 12° allowed the flow t increase from 480 to 520 ml. per minute. A 40 ml. per minute error is approximately 0.65 gallon per hour. A flow rate of 504 ml. per minute is 8 gallons per hour. At this rate the error is in the magnitude of 8 percent.

Extreme U. L. V. operations demand a degree of accuracy that is readily attainable in a laboratory. Under field conditions such accuracy is almost impossible to achieve. For example: A deviation in the flow meter reading equivalent to the diameter of the ball float will allow an error of 0.65 gallon per hour at a desired output of 8 gallons per hour. The flow meter has a 150 m.m. scale and a ¼ inch diameter float. In actual tests we have observed significant deviation in the output of a spray unit that has been statically calibrated from the actual output under operating field conditions. It is not practical to calibrate spray units, lacking monitoring instruments, before committing them to field operations and assume that the rate of application will remain constant.

It has recently been reported (Mount and Pierce, 1972) that minor changes in the operation of a U. L. V. machine greatly reduced the efficiency of the spray. In this case the air pressure at the atomizing nozzle varied by only 1.0 p.s.i. This slight increase in pressure resulted in an ineffectual spray being generated.

In a series of tests (Rathburn and Boike, 1972) discarded those in which the discharge varied more than 10 percent from the desired rate. The equipment had been calibrated by flow-meters over a range of temperatures. The equipment used was the same as or similar to that used by Mount.

The rate of flow of all fluids, including air, involved in the production of droplets in a spray-generating device must be under constant surveillance when the droplet size is near a critical limit. When the desired droplets approach a size so small that they will not impinge on the target, monitoring must be diligent. At the other end of the spectrum, monitoring must be equally diligent to insure that an increase in droplet size will not reduce the number of droplets per unit area to fewer than the effective number per square inch.

Inasmuch as temperature has a considerable effect on the rate of flow of liquids, it too, must be monitored. When a viscosity change occurs within the temperature range that will exist during field operations, the resulting deviations from the desired must be measured throughout that range. A change in viscosity will affect the flow of a fluid through the passages on the journey from the supply tank to the nozzle. A change in viscosity will change the reading of meters measuring the flow of the fluid. A change in viscosity will change the surface tension of the liquid. A change of surface tension will cause a change in the particle size of the spray being generated. Considerable forces are involved in overcoming viscosity and surface tension in spray generating devices.

Working with the Chevron Chemical Company in 1966 (unpublished) an aerial application of Dibrom was reduced to ½ fluid ounce per acre of concentrated (14 lb.) material. Excellent results were obtained. Attempts to further reduce the rate to below ½ fl. oz./acre gave very poor results. Mortality was reduced to a point not commensurate with the reduction of insecticide. A test was made using ½ fl. oz./acre of a solution of 1 to 1 Dibrom in heavy aromatic benzene. Excellent results were again obtained. When this solution was used at rates less than ½ fl. oz./acre, mortality was reduced.

Here we have evidence of a type of error inherent in U. L. V. operations. The reduction of mortality was not due to the lack of active insecticide, but to the lack of a sufficient number of spray droplets per unit area. Had the dose rate determinations been halted at the first indication of reduced mortality, approximately twice as much insecticide would have been indicated as was actually needed.

It appears that, when considering U. L. V. applications of a pesticide, the rate per unit area is not definitive (Furmidge, 1968). Serious consideration must be given to the number of droplets per unit area and the concentration of active ingredient in each droplet (Mount, 1970). The simple finding of an application rate that is effective is not sufficient. There is a minimum, practical rate of application for any control situation and this rate should be the goal of all conscientious mosquito control workers.

Observations and tests cast doubt on the efficiency and safety of U. L. V. operations at our present level of knowledge. Many factors affecting the toxicity of insecticides are unknown or disregarded, and the development of equipment to apply them, appears to lag behind the little we do know.

Any change in temperature, even 1 degree, may require recalibration (Thompson, 1972). Any change in the solution will require recalibration. A change of solvents, or extenders, or the addition of such materials as sludge eliminators will necessitate recalibration. Recalibration will be necessary even with a spray rig having the solution temperature thermostatically controlled whenever the solution is changed. Solution changes include substitutions and/or additions of solvents, additives, extenders and sludge inhibitors.

Mortality determinations should consider not only the rate per acre of the insecticide but also the rate per droplet and droplets per unit of area. When an effective rate is found, work should be extended to define that rate in terms of the amount of the insecticide in a specific solvent, of droplet size and droplets per unit area. By using a more dilute solution of insecticide, but maintaining the droplet size and number, it may be possible to reduce the rate per acre of the insecticide without affecting its efficiency.

An important cause of error in U. L. V. spraying is the evaporation of the solvent or diluent used (Seymour, 1969). Accurate measurement of the rate of application of a volatile spray solution is practically impossible. The use of diesel fuel oil #2 as a spray base has probably resulted in more drift to non-target areas than any other liquid except water. The evaporation rate of #2 oil is very rapid. In a free fall through air #2 oil droplets lose so much of their volume that their behavior is unknown just seconds after being generated at the spray nozzle.

The improved performance of slow volatilizing sprays was clearly demonstrated when malathion was used without diluents. The impact of this discovery resulted in the U. L. V. race. However, other insecticides did not give the considerable increase in mortality reported for malathion. When malathion is used with low volatile solvents, dilute solutions are fully as effective as the technical material. When Baytex or Dibrom are used with low volatile solvents it is possible to use lower dose rates than are currently recommended. It has been found that a heavy aromatic naphtha that distills in the range of 530° to 640° F. is satisfactory. The material should have a vapor pressure not greater than about 0.1 mm. Hg. at ambient summer temperatures (Ryder, 1970). Under local conditions, in the summer, approximately 90 percent of the above H. A. N., liberated as a fine spray, will reach the ground after a free-fall from a height of 100 feet (Thompson, 1970b). We have found Exxon W. K. 80 to be very satisfactory for this purpose. The same solvent, used to dilute insecticides for thermal fog application, results in better kill than when a highly volatile solvent, as #2 fuel oil, is used. Cold fog operations are greatly improved when a solution considerably less viscous than some technical grade insecticides is presented to the atomizing device. The amount of H. A. N. that can be used is limited only by its phytotoxicity.

The exact amount that can be used should be determined for each of the several situations where it will be used. There is no indication that H. A. N. is a danger to plant life under normal low volume spraying conditions.

It is our belief that, with the growing concern for the entire ecosystem, entomologists and mosquito control workers who are in a position to influence large segments of this system should be the most diligent to be a good influence on the entire system.

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