THE HISTORY AND THEORY OF MALATHION ULV APPLICATIONS FOR BOLL WEEVIL CONTROL

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Abstract

The Ultra Low Volume (ULV) insecticide application technique originated in the control of the desert locust in East Africa. Experiments were carried out shortly after World War II with solutions of DNOC and dieldrin in diesel fuel (Maas, 1971). ULV is defined as volumes of 0.5 gallons or less per acre. Maas (1971) reported that this development moved into crop spraying with the use of DDT and oils, but its development was encouraged by the good results obtained by American Cyanamid in the application of undiluted malathion. American Cyanamid (1970) states appreciation is expressed to the Plant Protection Division, Agriculture Research Service, United States Department of Agriculture, (now USDA Animal Plant Health Inspection Service, Plant Protection & Quarantine) for its assistance in developing the technical requirements for applying insecticide concentrates by aircraft. This ULV method (American Cyanamid, 1970) was developed in 1963.

This work began with trials carried out for control of rangeland grasshopper and is reported on by Messenger (1963) and Skoog et al (1965). Burgess (1965) reported on the first tests for boll weevil control. These tests compared 18, 14 and 9 oz. rates per acre of technical malathion to treatments of methyl parathion and azinphosmethyl in 3 gallons of water per acre. At the time of this research USDA was actively involved in grasshopper control over millions of acres of western rangeland and a diapause control program to keep the boll weevil from establishing on the large cotton acreage of the Texas High Plains. The Texas Boll Weevil Program was reported on by Adkisson et al (1965). This development allowed an airplane operator to spray 4 times the area per hour of flying time with 8 oz. per acre of malathion ulv versus the conventional insecticide in 3 gallons of water per acre (American Cyanamid, 1970). This meant tremendous cost savings for these USDA and Farmer/Rancher Cooperative Control Programs. It also meant the physical possibility of doing large acreage insect control programs. Further, this technology and chemistry is being used for wide-area mosquito control over populated areas by Public Health Organizations. Most recently New York City was sprayed to halt an encephalitis outbreak.

The history of the mechanics of aerial ULV application is reviewed by Maas (1971) and Akesson and Yates (1974). More recently the physical problems and solutions have been reviewed by the Spray Drift Task Force (1997) and Bohmont (1990). Ground application is thoroughly covered by Potts (1958) and reviewed by Bohmont (1990). There are basics that apply to all pesticide applications and applicators from hand held sprayers to airplanes. The basics that are of direct concern to the entomology profession are rates (amount of pesticide for efficacious control), coverage (distribution of spray in target area) and drift (contamination of nontarget areas). Other factors such as economic, ease of application and environmental and human safety are critical to the acceptance and use of an insect control procedure. These other factors are of joint concern to all professions involved.

Rates of malathion ulv for boll weevil control were further studied for use at different times of the cotton plant growth cycle by many researchers. Adkisson (1965) in Texas, Cleveland et al (1966) in Mississippi and Hopkins and Taft (1967) in South Carolina. In 1995 this author was requested to compare the 16 oz. per acre rate to a 12 oz. rate under actual Boll Weevil Eradication Program conditions. The 16 oz. rate had been used in the Eradication Programs which started in 1978 [reference to malathion use in earlier USDA Programs is found in Boyd (1976), Boyd and Brazzel (1973) and Rummel and Frisbie (1978)]. This 1995 decision was based on a change in manufacturers, formulation, increases in product cost and Program acreage. Jones et al (1996) showed that 12 oz. worked as well as 16 oz. using 40 acre grower fields as replicated plots and treated under Program conditions. This study led to the Texas Program changing to 12 oz. per acre in July 1995. Villavaso et al (1996) did small plot studies demonstrating the same results. These two studies led to the Southeast Program changing to the 12 oz. rate starting in 1996. Economic pressures led the Mississippi Program to reduce rates to 10 oz. per acre based on the results of 12 oz. and 8 oz. studies (Villavaso et al.1996). Villavaso (unpublished) did further plot work which support this decision.

Coverage and drift are related since pesticide spray that doesn't land in the target area obviously becomes a contaminate of nontarget areas. Brazzel et al. (1968) compared ultra low volume insecticide concentrates to emulsifiable concentrates (EC) in water. More spray droplets per square inch were recovered in the EC applications than the ULV. However, more insecticide was recovered from the ULV applications than from the EC. Their conclusion was that ULV formulations applied in droplet sizes ranging from 100 to 200 microns (micrometers) in diameter drifted less than EC water diluted formulations. Using a different technology Burt and Smith (1974) showed that droplets of 140 micron diameter (about 0.0055 inch) or larger are necessary for reasonably good drift control. With ULV rates of 16 oz. per acre this means that there will be 347 droplets

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per square inch if all droplets have a 150 micron diameter. If all droplets have a 300 micron diameter there will be 5.38 per square inch (Potts,1958). This spectrum of droplets with a volume median diameter of more than 140 microns while obviously not physically capable of complete plant coverage has been used successfully in boll weevil eradication. Adult boll weevils are found feeding and ovipositing in immature fruit in the plant terminal. The plant terminals at the top of the plant represent an area to be covered by droplet deposition not as great as lower part of the plant. The boll weevils' behavioral trait of moving from terminal to terminal increases the possibility of contact with impinged droplets on the plant.

The Spray Drift Task Force (1997) summarized their aerial application studies with the following points : droplet size is the most important factor affecting drift, drift only occurs downwind and current technology could not eliminate drift totally but could minimize it to levels approaching zero. They recommend the following to minimize drift: applying the coarsest droplet spectrum that provides sufficient coverage and control, continuing the standard practice of swath adjustment, controlling application height, using shortest boom length that is practical, and applying pesticides when wind speeds are low. These elements were all in place in Boll Weevil Program activities starting in 1978. The one exception was the shorter boom length requirement which was in place by 1983.

Ground equipment has one element that has hindered its use in application of malathion ulv. This is the more than 80 miles per hour that airplanes travel to prevent stalling. This speed has made it relatively simple to spread ultra low volumes of liquid across a land area. With ground equipment it isn't as simple but it has been done. Taft et al. (1966) tested malathion ulv for boll weevil control applied by mist blower on a high cycle sprayer. In 1969 Taft et al. developed a boom type high cycle sprayer using air to replace the high volume of liquid required in normal boom type sprayers. Burt et al (1967) developed a boom type sprayer using a spinning disk and a metering nozzle for each row. While all three of these worked for ULV applications, their only use was in research studies.

The 1978 Boll Weevil Eradication Trial Program used mist blowers mounted in the beds of pickup trucks for spraying to assist aircraft coverage under wires, near buildings and around tree lined fields. These mist blowers applied azinphosmethyl in water at a volume 1.5 gallons per acre. These were converted to use 16 oz. per acre of malathion ulv by Jones (1984 USDA APHIS PPQ Report) and Mabry (1984 USDA APHIS PPQ Report) for use in the 1984 early season. This use continues to present in the Eradication Programs. In 1994 the Southeast and Texas Eradication Programs had high cycle boom type sprayers converted to apply ULV. This conversion utilized metering pumps and air blowers based on a design by McWhorter and Hanks (1992). These sprayers apply 16 oz. of malathion ulv mixed with an equal volume of once refined cottonseed oil per acre. Control efficacy with this ULV mixture on boll weevil is reported on by Mulrooney et al (1997). The introduction of these metering pumps (Hanks and McWhorter, 1991) was the basis for D. D. Clayton (personal communications), an equipment specialist with the Southeast Eradication Program to once again mount a mist blower on a high cycle sprayer. This system has eliminated the fragile boom system and makes whole field ground applications simpler. These conversions were found throughout the active Eradication Programs as of 1999. Coverage and drift studies comparing this new mist blower using the 16 oz. rate of malathion ulv to the boom sprayer with the 32 oz. vegetable oil mixture with malathion found little to vary except for the difference in volume (Mulrooney,Unpublished).

Mixing malathion ulv with vegetable oils has been studied by Harris and Jany (1986) with the introduction of a new product formulation that was 46.2% malathion ulv (technical) mixed with vegetable oils and emulsifiers. This formulation had a label (Cyanamid, 1986) with recommendations for boll weevil control on cotton listed from 18 to 36 oz. per acre. Jones et al (1998) reported on topically applied malathion in both cottonseed oil and paraffinic oil. The studies developed the LD50 for each treatment's mortality to the boll weevil. It should be noted that malathion ulv will mix alone with vegetable oils but not with paraffinic oils. Mulrooney (Unpublished) has found that reduced rates of malathion ulv mixed in once refined cottonseed oil show equal control efficacy to Program standard rates of malathion ulv alone. Acceptance of these mixtures will probably be an economic decision.

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