# MALATHION AND BOLL WEEVIL ERADICATION: APPLICATION RATES, MISTBLOWER EFFECTIVENESS, AND BAIT STICK QUALITY EVALUATION

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## Abstract

This paper briefly summarizes the malathion work conducted at the USDA, ARS Mississippi State, MS location over the past 5 years. Aerially-applied malathion at rates of 4, 8, 10, 12, and 16 oz/acre were tested from 1995 through 1997 for their effectiveness on boll weevils. Dose-mortality data and rain-steadfastness data also were collected. Additionally, we conducted studies that established curves of malathion deposition and boll weevil mortality that could be expected on leaves sampled at various distances from the mistblower. In 1999 a significant relationship between malathion on the surface of bait sticks and boll weevil mortality was established.

## Introduction

An early study with aerially applied ULV (ultra-low-volume) malathion showed rates of 9, 14, and 18 oz. per acre to be effective against the boll weevil and not significantly different from each other (Burgess 1965). Other studies showed no difference in mortality of boll weevils in the field following aerial applications of 8, 12, or 16 oz. per acre (Cleveland et al. 1966), and a rate of 4 oz. per acre was shown to be effective (Hopkins & Taft 1967). In the latter study toxic effects of malathion diminished to unacceptable levels 48 hours after application or following rainfall of 0.5 inches. Nemec and Adksisson (1969) also reported significant reductions in toxicity of ULV malathion to boll weevils following 1" of simulated rainfall and slight reductions in toxicity of plants subjected to dew. A more recent study showed no significant differences in either malathion residues or boll weevil mortality following aerial applications of 0.88 L per ha (Kirk et al. 1997).

Malathion is the most costly single item required for eradication. Each 2 oz./acre reduction in malathion rate reduces costs about 30 cents per acre per application. With many applications over millions of acres, substantial savings to cotton producers are realized. The potential for such savings prompted additional studies in the mid 1990's to determine if the standard boll weevil eradication rate of 16 oz. per acre could be lowered. Results indicated that boll weevil mortality induced by 12 oz. of malathion per acre compared favorably to that of 16 oz. per acre (Mulrooney et al. 1995, Mulrooney et al. 1996, Jones et al. 1996, Villavaso et al. 1996). As a result of these studies and the need to reduce the cost of eradication, the 12 oz. per acre rate of malathion was widely accepted as adequate for eradication (in Texas, Louisiana, and Arkansas, for example). To further reduce eradication costs, Mississippi adopted a rate of 10 oz. per acre.

Truck-mounted mistblowers are valuable tools for eradication. This equipment is used to apply malathion to the perimeters of cotton fields and in areas such as those traversed by electric power lines where less than adequate deposition of malathion is expected. “Hot spots” of boll weevil activity frequently occur in these areas, and liberal use of mistblowers is required to prevent their development. Tests were conducted in 1996 comparing two brands of mistblowers and quantifying the deposition of malathion and the amount of boll weevil mortality that could be expected at selected distances from the their paths of travel.

Judicious use of boll weevil bait sticks (McKibben et al. 1990) can expedite boll weevil eradication. These attract-and-kill devices are thought to be especially effective in areas where cotton was planted the previous year, but not the current year, and where adjacent overwintering sites harbor significant boll weevil numbers. Bait sticks deployed near the previous year fields can prevent large numbers of weevils from reaching the current year plantings. Bait sticks can decimate very low populations of boll weevils (Smith et al. 1992), and may be useful against low populations in areas where large-scale applications of malathion are undesirable. The effectiveness of bait sticks in killing boll weevils landing on them has been erratic and not strongly related to the amount of time they are in the field (Villavaso unpublished). Tests were conducted to determine if a relationship existed between the amount of malathion present on the surface of the bait stick and boll weevil mortality. This relationship could then be used to predict mortality by relatively simple analytical means and to write standards for bait stick quality similar to those used for pheromone dispensers used in eradication.

## Materials, Methods, Results, and Discussion

### Rate Tests

Tests were conducted in 1995-96 on leased land adjoining the Delta Research and Extension Center, Stoneville, MS and on commercially grown cotton near Tribbett, MS. In 1995, malathion (FYFANON® ULV; 95%; 1.17-kg/liter;

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CHEMINOVA, Lemvig, Denmark) was aerially-applied in 2-3 swath plots at rates of 8, 12, and 16 oz./acre; in 1996, the 16 oz. rate was replaced with a rate of 4 oz. per acre. Application was made using an Air Tractor 402 – air speed, 225 km/h; pressure 262 kPa; 4, 9, 13, and eighteen 8002 flat-fan nozzles (Spraying Systems, Wheaton, IL) for the 4, 8, 12, and 16 oz. rates, respectively. In 1997, rates of 10, 12,and 16 oz. per acre were tested near Starkville, MS on approximately 400 acres using eradication program airplanes and personnel.

Malathion toxicity was evaluated by collecting leaves from treated plants and placing them into 100-mm petri dishes with laboratory-reared boll weevils – one leaf per dish, one weevil per leaf. Leaves were taken at 0, 24, 48, and 72 hours after application. Dishes were held at approximately 27ºC, and mortality was noted 24 hours later. Additionally, we were able to observe the effect of rainfall on malathion toxicity during the course of this study, and rainfall became the deciding factor in determining how many days after application leaves would be tested.

In 1995 no significant differences ($P > 0.05$) between the 8, 12, and 16 oz. rates were seen for the 4 sampling periods, but a trend toward increased mortality with increased rate was apparent 0 and 24 hours following treatment. Mortality for the 16 oz. rate was 100, 98, 65, and 35% for the 0, 24, 48, and 72 hour sampling periods; for the 12 oz. rate 98, 94, 80, and 62%; and for the 8 oz. rate 90, 80, 85, and 65% for the same periods. In 1996 rainfall prevented us from obtaining data past 48 hours after treatment. Significantly less mortality was observed for the 4 oz. rate than the 8 or 12 oz. rates for the 0, 24, and 48 hour samples. Mortality was 99, 83, and 85% for the 12 oz. rate, 95, 90, and 95% for the 8 oz. rate, and 62, 55, and 55% for the 4 oz. rate at 0, 24, and 48 hours after application, respectively.

Test plots received rainfalls of 0.05 and 0.10 inches during 1995 tests. Mortality of boll weevils placed on leaves collected before and after the rain was 98 and 38%, respectively, indicating that seemingly minor amounts of rainfall can cause major declines in mortality. These findings should alert boll weevil eradication personnel of the importance of reapplication of malathion following even light rainfall.

In 1997, 24-hour mortality for the 16 oz. rate averaged 99% for samples taken at 0, 24, and 48 hour; 99, 99, and 97% for the 12 oz. rate; and 95, 99, and 87% for the 10 oz. rate. Mortality was observed to occur somewhat faster for the 12 and 16 oz. rates than for the 10 rate. Mortality of boll weevils collected from white flowers in the field averaged 55, 20, and 25% for the 16, 12, and 10 oz. rates at 2 hours after weevils were placed on leaves and 85, 70, and 55% at 4 hours, but by 4 hours, mortality was at least 95% for all 3 rates. When weevils were placed on treated leaves for periods of 30 minutes to 4 hours and then moved to a non-toxic environment, 24 hour mortality averaged 95, 80, and 75% for the 16, 12, and 10 oz. rates following 30 minute exposure; 90, 100, and 95% following a 1 hour exposure; 100, 100, and 90% following a 2 hour exposure; and 100% mortality occurred in all 3 rates following a 4 hour exposure. In another test with 0-3 day old weevils, a non-significant trend toward slower occurrence of mortality in older weevils was seen. Overall, significant mortality occurred in all malathion treatments tested, but it tended to be slightly higher and occur somewhat faster as rate increased.

**Mistblower Tests**

Two types of commercially available mist blowers were tested: "Automatic" (Automatic Equipment Manufacturing Company, Pender NE), which has been the standard mist blower for the boll weevil eradication program, and "Big John" (Big John Manufacturing, Inc., Osmond, NE), a recent addition. Mistblowers traveled at a speed of 5 mph and were calibrated to dispense 16 oz. of 95% malathion per 290 yards of travel. Plots were arranged on both the leeward and windward sides of the field so blower performance could be evaluated both with and against the wind even though boll weevil eradication criteria prohibit operators from directing sprays into the wind. Within 2 hr after treatment, leaves at selected distances from the mistblower were picked and taken to the laboratory for the same type of bioassay used in the rate test above.

The distance at which 50% mortality could be expected was 63' and 30' from the paths of mist blowers spraying with and against the wind. Malathion deposition on the leaves averaged about 2.5 μg per $cm^2$ of leaf surface at those distances. No significant difference in the performance of the 2 mistblowers tested was observed.

**Bait Stick Tests**

Boll Weevil Attract and Control Tubes (BWACT's) were supplied by Plato Industries, Inc., Houston, TX. Five bait sticks were tested immediately after removal from the boxes they were packaged in and the remaining sticks were placed in a grassy plot outside of the laboratory for future testing. Sticks were subjected to both bioassay and chemical assay. For the bioassay, ten boll weevils were placed, one at a time, on each of the 5 sticks and allowed to crawl on the stick for 30 seconds. Weevils were then removed from the sticks and placed in petri dishes until mortality was recorded 24 hours later. Immediately after the bioassay on each stick was completed, chemical assay was conducted. Three 3" sections were cut from each stick and the outside surfaces of each section were rinsed with 10 ml of hexane to extract malathion from their surfaces. A Hewlett-Packard 5890 gas chromatograph equipped with a flame photometric detector, an auto-sampler, and Chemistation (Hewlett-Packard) software was used to quantitate malathion residues.

Preliminary results indicate that to ensure 100% mortality of weevils that crawl on the sticks for 30 seconds, the 10 ml rinse must contain no less than 30 ng of malathion per μl hexane.

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