MALATHION ULV RESIDUAL CONTROL EFFICACY UNDER BOLL WEEVIL ERADICATION PROGRAM CONDITIONS

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Abstract

Malathion ulv at an aerial application rate of 12 oz. per acre gave excellent coverage for boll weevil control. Extended residual efficacy was found under differing Boll Weevil Eradication Program conditions in Texas and Mississippi. Applications were compared under drought and humid conditions through bioassay with lab reared boll weevils on collected cotton leaves. Mortality dropped from 100 % after 48 hours exposure to 90% at day 4 post treatment and to 35% on day 11 under drought conditions. Under humid conditions mortality remained at 100% through day 7 at which time a second application was made. With boll weevil mortality at 100% for several days the alkaline dew was concluded not to be an important factor in the decomposition of malathion ulv. Dew dripping from the leaves was shown to carry malathion ulv with it. However, rain was found to be the cause for reduced toxicity.

Introduction

Malathion ulv is the insecticide of choice for the Boll Weevil Eradication Programs. This is based on the following reasons: economic, ease of ultra low volume (ulv) application, safety to humans and excellent control efficacy for the boll weevil. Thus, no other insecticides can presently replace it. Malathion ulv is the technical form of malathion or undiluted concentrate with few inert ingredients. Since Cheminova Agro A/S, Lemvig, Denmark began manufacturing this product it has been a consistent 95% malathion concentrate. The physical property of malathion is that of an oil. It has been formulated in a variety of ways for mixing and application. Wolfenbarger (1996) demonstrated that toxicity to the boll weevil was reduced by mixing with water. Since malathion ulv is not mixed with water, this is not a problem. However, dew formation on the cotton leaf creates an aqueous environment for malathion drops after application. This dew was shown by Andrews and Sikorowski (1972) to have an alkaline pH. A variety of elements were also analyzed from these dew samples taken from Mississippi cotton (Andrews and Sikorowski, 1972).

The residual efficacy of malathion ulv rates under actual Boll weevil Eradication Program field conditions for boll weevil control was studied in 1995 by Jones et al (1996). This study led to the acceptance of a rate reduction by the Programs from 16 oz. per acre to the present 12 oz. rate. With no dew present, further studies were planned including the analysis of dew on cotton in the Rio Grande Valley of Texas to compare to Andrews and Sikorowski's (1972) findings. Simulated rain and dew studies by Nemec and Adkisson (1969) showed that rain and not dew reduced the toxicity to boll weevil. The dew used in their studies was simulated by spraying water on the plants prior to insecticide application. This did not take into consideration the pH and chemicals found in naturally formed dew on cotton plants.

Methods and Materials

A series of cotton plots were established on the Mississippi State University Experiment Station North Farm adjacent to the Campus. These were five 350 foot plots, each composed of 20 rows of cotton planted at a 39 inch spacing. Each of these were separated by 5 rows of tobacco. These plots were fully exposed with no obstacles for aerial application. Application of malathion ulv at 12 oz. per acre was made with a Turbo Thrush agriculture spray aircraft as part of the Boll Weevil Eradication Program. Application procedures and scheduling were done by Program personnel. Each 20 row plot was covered by one swath of the aircraft. Each plot or swath was sampled at rows 3, 9, 12 and 18 starting from the east side of the field. The bioassay with lab reared boll weevils consisted of 3 upper leaves clipped from one plant at each of the four sample sites. Scissors were used to cut the petioles with the leaves falling into a petri dish so no hand contact was made. These dishes were labeled as to row number and plot number. On return to the laboratory 5 active lab reared adult boll weevils were placed in each petri dish with its 3 treated leaves. These were held for 48 hours prior to mortality counts. Untreated controls were set up in the same manner using freshly washed and rinsed cotton leaves. This compared a total of 20 treated sets of leaves to 8 untreated sets each time. The first series was done daily for seven days. Other tests varied on days tested but all tests included 0 day after application to determine coverage of each swath. The same methods were used in the 1995 Texas test (Jones et al, 1996) but with 38 acre plots replicated 5 times.

Oil sensitive spray cards were stapled to plant leaves at three levels per plant at each plot sample site. This included cards prior to each application for deposition and coverage and cards immediately after application for wash off studies. The cards were positioned under the center leaf tip and held with 3 staples so that half of the spray card protruded past the tip. The cards detecting spray coverage were removed after application. The cards detecting wash off were examined each sample day and presence of malathion ulv and pattern was recorded. On each sample day the upper most leaves of the cotton plants adjacent to those with leaves clipped were examined visually for signs

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of malathion ulv drops. On the occasions when the oil was not seen spray cards were pressed to the leaves and malathion ulv presence was recorded.

The presence of dew was observed early every morning during the 1996 malathion ulv spray study periods in Mississippi. In Texas the dew on cotton leaves was sampled after rains came to the study area (Jones et al, 1996). This study used a Unifet Fieldlab-100 microprocessor pH meter to test the dew on the leaf. Twenty leaves were sampled and pH recorded each 30 minute period for the leaf wetness period on each of five days.

For chemical analyses of leaf washes a total of 40 samples were collected at the USDA ARS Research Station at Weslaco, Texas. This was 20 leaves washed with 20 ml of reagent grade (Milli Q) water and the wash water collected in a sample jar. The other 20 leaves were placed in individual jars with 20 ml of MilliQ water, shaking the jar for 8 seconds and then removing the leaf. Both types of samples were done 2 per day and 3 times per week until all 20 of each type of sample were collected. Leaf wash samples were taken from cotton leaves in untreated cotton plots. These samples were send to the Frank Hernandez Environmental Laboratory, Texas A & M University Research Center, El Paso for analysis.

Results and Discussion

The per cent mortality is presented (Table 1) for both the 1996 and 1995 bioassays. All bioassay tests demonstrated excellent coverage of the upper third of the plants across the study fields with 12 oz. of malathion ulv per acre. There was dew present on the cotton leaves each morning of the 1996 study. The first 4 days had dew at a drip off rate. Thirty-two point five per cent of the spray cards had signs of malathion ulv in a wash off pattern when examined 20 hours after the first late afternoon application (8-14-96). No other malathion ulv wash off by dew was observed in these studies and dew was not present during the Texas study. Under the more humid Mississippi conditions the bioassay per cent mortality remained 100 % for the 7 days post application. The untreated controls had near 100% survival at the same time. The later studies while not as long due to rain help support this long residual efficacy of malathion ulv. Visual and spray card sampling for malathion ulv drops on the upper most leaves of the cotton plant showed their presence every day bioassay mortality was demonstrated. This extended control efficacy demonstrated by bioassays done for two separate years is supported by the 4.6 day half-life on cotton found in laboratory analysis of malathion ulv by Awad et al (1967) and its long persistence on lima beans (Wheeler et al, 1967). The bioassays also demonstrate that rain is detrimental to the residual efficacy of malathion ulv for boll weevil control. This is in agreement with the results of Nemec and Adkisson (1969) under simulated conditions.

The pH of the Texas dew samples is summarized in Table 2 and compared to the Mississippi study (Andrews and Sikorowski, 1972). Both studies show that the dew in both regions is alkaline. The Texas leaf wash samples were tested by three chemical lab procedures. The ICP showed the presence of cations which were sodium, potassium, calcium, and magnesium. The IC showed the anions, which were chlorine, nitrate and sulfate. The Titration procedure showed bicarbonate and calcium carbonate for alkalinity. The Mississippi study was a partial analysis showing sodium, potassium, calcium, carbonate and bicarbonate. There are too many unconsidered variables for a true comparison of these tests other than there are similarities in findings. We conclude that the cotton in the two geographical areas is similar. Enough that the results of malathion ulv efficacy tests for boll weevil control and residual control have meaning regardless of where the work is done. Malathion ulv (technical malathion) does not contain emulsifiers. It does not mix with water so the work by Wolfenbarger (1996) on other formulations has no application. The long residual effects of at least 7 days with dew formation on leaves each day demonstrates that dew is not important in causing malathion ulv to deteriorate. However, rain or wash-off can impair levels of extended toxicity.

The results of this work indicate the need for descriptive monitoring of the microclimate of the cotton field related to dew formation or leaf wetness and duration. This phenomena and the temperature inversions at or above the cotton canopy can influence impingement of malathion ulv spray drops on the cotton plant. A better understanding is needed for more effective and economical control decisions. The Eradication Programs could use this bioassay technique and spray cards to monitor the presence of malathion ulv drops on the upper leaves of cotton plants. As long the oil drops are there the insecticide is present and toxic. This information would allow them to lengthen spray intervals which are mainly on a 7 day schedule. It has the possibility of demonstrating that their problem fields are getting poor or no spray coverage.

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Table 1. Boll Weevil Mortality after 48 hours on malathion ulv treated cotton leaves in Texas (1995) and Mississippi (1996).

Date	Day	% Mortality 48 h	Maximum Air Temp Fº	Rain Inches	Dew
		MISSISSIPPI			
8/14	0	100	85	0.00	Yes
8/15	1	100	88	0.00	Yes
8/16	2	100	90	0.00	Yes
8/17	3	100	92	0.00	Yes
8/18	4	100	92	0.00	Yes
8/19	5	100	92	0.00	Yes
8/20	6	100	90	0.00	Yes
8/21	7	100	90	0.00	Yes
8/21	0	100	90	0.00	Yes
8/24	3	100	93	0.00	Yes
8/25	4	--	90	0.75	Yes
8/26	5	33.0	89	0.00	Yes
9/10	0	100	86	0.00	Yes
9/13	3	100	76	0.00	Yes
9/14	4	100	83	0.00	Yes
9/15	5	100	83	.43	Yes
9/16	6	7.0	89	.14	Yes
		TEXAS			
5/04	0	100	88	0.00	No
5/06	2	100	90	0.00	No
5/08	4	90.2	89	0.00	No
5/10	6	72.4	93	0.00	No
5/11	0	100	95	0.00	No
5/13	2	100	93	0.00	No
5/15	4	90.0	97	0.00	No
5/17	6	65.7	94	0.00	No
5/19	8	45.2	90	0.00	No
5/22	11	35.0	87	0.00	No

Table 2. Dew pH on cotton leaves taken at 8:00 A.M. for five days: Average for Mississippi[1] and Rio Grande Valley Texas.

Date (1995)	pH	Date (1972)	pH
6/13	8.15	8/07	8.42
6/14	8.29	8/16	8.80
6/15	8.60	8/27	8.60
6/16	8.52	9/09	8.20
6/20	8.49	9/10	8.88

[1] Andrews and Sikorowski (1972). Means between states not significantly different when compared with t- test (p=0.05).