TEMPORAL DEGRADATION OF ULV MALATHION UNDER FIELD CONDITIONS

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Abstract

Field studies were conducted in central Texas to determine the extent of ULV malathion degradation over time and in the presence or absence of sunlight. The purpose of the work was to obtain a better understanding of the factors contributing to ULV malathion degradation, so future steps can be taken to combat the rapid degradation seen with the material. Studies showed that malathion degraded more rapidly in sunlight. There was also significant degradation of the material over time.

Introduction

Malathion is the most commonly applied insecticide used in the boll weevil eradication program and has been evaluated by several researchers (Cleveland et al., 1966; Furr and Merkel, 1967; and Scott and Lloyd, 1975). The chemical is relatively inexpensive, easy to apply, safe to human, and still provides effective control of boll weevils (Jones et al., 1996). With the emergence of eradication programs, researchers have evaluated ever decreasing rates of malathion (Leggett, 1989; and Jones et al., 1996). The thrust of this research has been to lower the active ingredient rates, which translates to more economical applications, and to maintain effective suppression of boll weevils. As the minimum threshold of overall effectiveness of malathion is approached, it will become increasingly important to maximize the on-target deposition and efficacy of every malathion application.

A better understanding of the factors contributing to the degradation on the material under field conditions may lead to improvements in efficacy. The degradation of malathion has been shown to significantly increase with temperature (Abdel-Kader et al., 1980, and Wintersteen and Foster, 1992). Researchers have found that the presence of a heavy dew does not affect efficacy (El-Lissey et al., 1997) or degradation (Kirk et al., 1997); therefore, the author felt that some of the degradation that is seen in under field conditions may be the result of photolibility. This information may lead to the use of UV protectants to increase efficacy.

Objective

- Examine the temporal degradation from an ULV malathion application deposited on leaves and mylar cards.
- Determine the level of degradation of ULV malathion in sunlight versus no sunlight on leaves and mylar cards.

Materials and Methods

Applications of ULV malathion at the rate of 0.88 L/ha (12 oz/acre) using the application guidelines from the Texas Boll Weevil Eradication Foundation for a Cessna Ag-Husky were made in August and September, 1998. One four-swath application was made during each month. The applications were made in a cotton field that had not been previously treated with malathion. Forty mylar cards on holders (Figure 1), to keep the cards level with the top of the foliage, and 20 potted cotton plants were placed into the cotton field (Figure 2) prior to the application of ULV malathion. To facilitate studying the effects of sunlight on malathion degradation, the samples were split into two batches: field and dark samples. Following each treatment, the potted plants were moved to a dark room (August study) or to a covered area in the field (September study), which prevent the plants from receiving any direct sunlight. The plants were placed in the covered area so that they would be exposed to the same temperature and humidity plants in the field. Twenty of the mylar cards were removed from their holders and stored in a rack with the potted plants (dark samples) while the other 20 cards were left in the field to be exposed to sunlight (field samples).

After an application was made and the samples moved to their appropriate location, samples were taken 0, 24, 48, and 72 hours after treatment (HAT). Ten leaves and five mylar cards were taken from each batch (field vs. dark) of samples. Leaves were selected from the tops of each the plants growing in the field and from the potted plants. Each leaf and mylar card was placed in an individually labeled Zip-loc© type plastic bag, stored in an ice chest with blue ice, then transported back to the laboratory for analysis. Analysis consisted of washing the leaf or card in the bag with 20 ml of methanol. Bags were shaken vigoriously, with care being taken to adequately wash both sides of the leaf and cards. A 2 ml sample was then taken and placed in glass, sealable GC vial for gas chromatography analysis. The leaf was then taken out of the bag and the leaf area measured using a leaf area meter (Model #LI-3100, Li-COR, Inc., Lincoln, NE). Mylar cards were precut to have a surface area of 100 cm^2. The area measurements were used to convert the deposition data to a dosage per unit area measurement.

Malathion was quantified using a Hewlett-Packard 6890 gas chromatograph with flame ionization and a J&W DB-1 dimethylpolysiloxane column (30 m X 0.32 mm X 0.25 μm) with a 2 ml/min flow of helium. The chromatograph and auto sampler were operated with Hewlett-Packard's

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Chemstation software. The operating parameters for the chemical analysis were: injector temperature - 120°C, detector temperature - 250°C, oven program - 60°C initial temperature held for 2 min, then the temperature was ramped 30°C/min for 5 min, a 5°C/min increase for 4 min, 35°C/min for 2 min. The retention time of the malathion was 9.08 min. The oven was allowed to cool before the next samples was injected.

Results

August Study

The mean values for the deposition on the leaves and mylar cards for the August study are shown in Figure 3. There was no significant difference between the field and dark leaf samples. There was significant degradation of malathion over time ($F=53.7$, $df=3$, $P<0.0001$). The deposition was significantly higher at 0 HAT than at the other three times using Duncan's test for mean separation ($\alpha=0.05$). The interaction between light conditions and time was not significant.

For the mylar cards, there was a significant difference in field and dark samples ($F=34.8$, $df=1$, $P<0.0001$) and a significant time effect ($F=6.3$, $df=3$, $P<0.0020$). There was significantly more material on the mylar samples held in the dark. The samples at 0 and 24 HAT had higher levels of malathion than those at 48 and 72 HAT. The interaction between the two effects was not significant.

September Study

The mean values for the deposition on the leaves and mylar cards for the September study are shown in Figure 4. Due to an error during the analysis of the 72 HAT samples for both the leaf and mylar samples, the 72 HAT was not included in the data analysis as indicated by the reduced degrees of freedom (df) in the time effect analysis. There was a significant difference between the field and dark leaf samples ($F=84.9$, $df=1$, $P<0.0001$), with the leaf samples held in the dark having a significantly higher overall deposition. There was a significant degradation of malathion over time ($F=7.7$, $df=2$, $P<0.0013$). The deposition was significantly higher at 0 and 24 HAT than at 48 HAT using Duncan's test for mean separation ($\alpha=0.05$). The interaction between light conditions and time was not significant.

For the mylar cards, there was a significant difference in field and dark samples ($F=5.8$, $df=1$, $P<0.0261$) with the dark samples having higher deposition measurements than the field samples. The time effect was nonsignificant ($F=0.11$, $df=2$, $P<0.8988$). The interaction between light conditions and time was not significant.

Discussion

The results from ULV malathion degradation studies showed that samples held in the field had significantly lower levels of deposition than samples held in the dark in three out of four cases. This suggest that the hypothesis that some the degradation of malathion is caused by sunlight was valid. The inclusion of an UV protectant may help to keep some of the malathion from degrading and will be investigated in future studies. There was a significant degradation over time for the leaves and mylar cards in three of the four cases. The published literature also shows that malathion degrades rapidly over time. None of the interactions between light conditions and time were significant.

In general, the mylar cards had higher deposits than the leaf samples. Some of the variability in the deposition data may have been due to the differences in collection efficiency, which is always a factor in deposition data. The mylar cards were held flat and rigid, while the leaves were allowed to move with the wind currents. The important factor is that the two sampling methods, generally, gave the same results.

Summary

A study was conducted to determine the effects of sunlight on the degradation of ULV malathion. Samples that remained in the sunlight had lower deposits (i.e. higher rates of degradation) than samples stored out of the sunlight. There was a significant amount of degradation over time as was expected. As the boundaries of biological efficacy are approached with lower and lower rates of ULV malathion, any improvement in the retention of the material in the field will likely result in improved efficacy.

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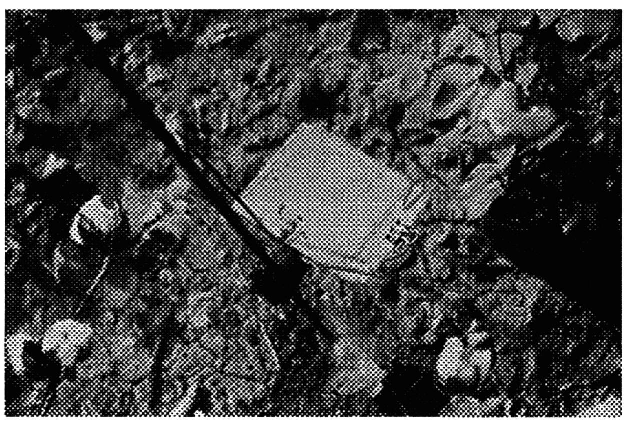

Figure 1. Mylar card holder.

Figure 2. Potted cotton plants and mylar card holders placed in the field.

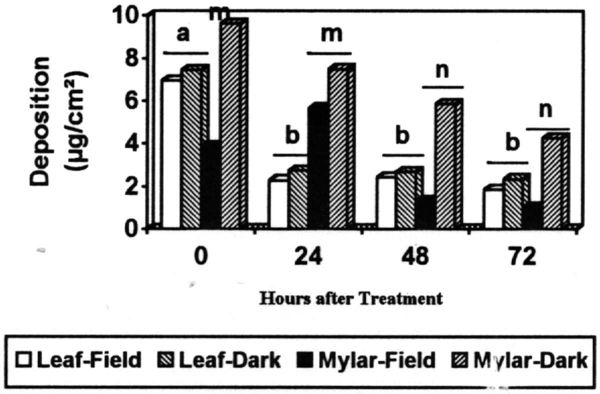

Figure 3. Deposition of ULV malathion on cotton leaves and mylar cards in August, 1998. (Means in columns for each sampler type (field and dark samples combined) followed by the same letter are not significantly different at 0.05 level of confidence.

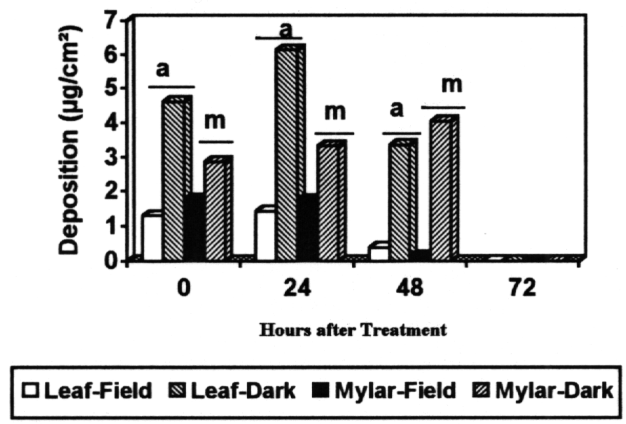

Figure 4. Deposition of ULV malathion on cotton leaves and mylar cards in September, 1998. (Means in columns for each sampler type (field and dark samples combined) followed by the same letter are not significantly different at 0.05 level of confidence)