DISSIPATION OF METHOMYL RESIDUES ON THE FOLIAGE OF GREENHOUSE-GROWN CUCUMBERS, 1991

By

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SUMMARY

The dissipation of methomyl on foliage following application in a greenhouse situation has not been extensively evaluated for potential hazards to workers with foliar contact. Treatment of greenhouse-grown cucumbers was conducted with ultra low volume equipment. The half-life was found to be within the range of 2.5 to 4.0 days. The initial deposition was estimated to be within the range of 0.044 to 0.087 ug/cm². It would appear that workers entering a greenhouse, under the conditions studied, could harvest cucumbers at 48 hours post-application with minimal exposure. Protective clothing after the expiration of the reentry interval, would not appear to be necessary under the conditions studied.
INTRODUCTION

Methomyl, the common name for S-methyl-N((methylcarbamoyl)oxy)-thioacetimidate, is a broad spectrum insecticide used on row crops, grains, alfalfa, grapes, tree fruit and ornamentals. It is sold under the trade name of Lannate. Methomyl has an oral LD50 reported to be 12-48 mg/kg (rat) and a dermal LD50 reported in the range of greater than 1000 to more than 2400 (rat) and 556 to greater than 1500 mg/kg (rabbit) (Hayes and Laws, 1991). The insecticide is a restricted use material and is a toxicity category 1 pesticide.

In 1988, workers girdling grapes, 10 days after methomyl had been applied, became ill with symptoms related to cholinesterase inhibition (O'Malley et al., 1991). O'Malley et al. (1991) determined the safe work level for grape girdlers to be 0.1 ug/cm². Following this incident, dislodgeable foliar residue (DFR) studies were conducted to characterize the dissipation of methomyl on grape foliage. These studies demonstrated that methomyl, as used on grapes, exhibits increasing persistence from late spring to early fall (Reeve et al., 1990). The environmental factors associated with the increased persistence are not known. As a result of the illnesses and the DFR work, the 7-day reentry interval for grapes was lengthened to 21 days if the application is completed after August 15.

In 1991, a Special Local Need (SLN) registration was issued for the use of methomyl on greenhouse-grown cucumbers to control melon aphids. The SLN label requires a 48-hour reentry interval and suggests that workers be asked to wear protective clothing when entering the greenhouse after the expiration of the reentry interval. The plants within the greenhouse are large with no space between rows, thus there is the potential for extensive worker contact with treated foliage. The dissipation of methomyl in a greenhouse environment has not been extensively evaluated. In this study we collected dissipation data and calculated residue half-lives for comparison with those collected in grapes.

MATERIALS AND METHODS

Application Site:
In conjunction with the registration process, the Worker Health and Safety Branch was contacted by a greenhouse grower from Tuolumne County. He was interested in cooperating in a residue dissipation study to evaluate the potential hazards to workers at the expiration of the 48-hour reentry interval. The greenhouse consisted of four houses, each enclosing 1.25 acres of cucumbers plants. Each house contained approximately 59 rows with 105+ cucumber plants per row. The northwest and southwest houses contained fully mature, producing plants. The southeast house contained plants that were recently transplanted and had only 1-3 leaves on each plant at the time of application. The northeast house contained fully mature plants that had been badly damaged by aphids. The plants in this house were eventually removed and destroyed four or five days after the methomyl applications.

The cucumber plants are trained to grow vertically and grow to a height of approximately 7-8 feet. The plant containers allow for an aisle of approximately 3-4 feet. However, when the plants mature the aisle space is filled in by the plant leaves. A worker cannot walk between rows without considerable contact with the foliage.

The houses are maintained at a temperature of 80°F ± 3°. Heat is supplied as waste heat from a nearby lumber mill. The relative humidity of the houses is kept at 78% ± 4%.

Application:
Lannate Insecticide was applied at the rate of 0.5 lb./acre (0.45 lb. active ingredient(ai)/acre) in 2 gallons of diluent (water and carrier). The application was made using an ultra low volume Dyna-Fog fogger. The applicator pulled the fogger, mounted on a trailer, the length of the house while releasing the material behind the rig. The application takes about 30 minutes for each house. Ventilation fans within each house are turned on at the completion of the application to aid in dispersal of the material throughout the house. Prior to worker reentry, each house is ventilated to the outside and the interior ducts are cleared of material.

Sample Collection:
Five rows in each house were randomly selected throughout each of the four houses. Samples were not collected within a border of approximately 10 feet around the edge of each house. The rows to be sampled were identified and marked as were the beginning and end of sampling location within each row. Leaf discs were collected from the marked plants according to methods adapted from Gunther et al. (1975) and Iwata et al. (1977). Forty leaf discs were collected from each row using a Birkestrand\ leaf punch. The discs are collected in a 4-ounce glass jar. Each disc has a surface area of 10 cm² (both sides of the disc). Leaf discs were collected from mature leaves that were likely to have been on the plant at the time of application. Samples were collected about 8 hours prior to application, and at 18 hours, 42 hours, 4 days, 7 days and 13 days post-application. All samples were capped and stored on ice for transportation to the laboratory.

**Sample Analysis:**
Leaf discs were extracted within 24 hours of collection. Methomyl residue was washed from the surface of the leaf discs using a water/surfactant (dioctyl sodium sulfosuccinate) solution. The residues are then extracted from solution with dichloromethane. The extract is dried and methanol is added to resuspend residues. Determination of methomyl is by liquid chromatography. The minimum detectable level was 0.2 ug/sample (0.0005 ug/cm²).

**Data Analysis:**
Residues reported from the laboratory were converted from ug/sample to ug/cm² and then transformed using the natural log of the residue concentration. Least-squares linear regression was performed on the natural log of the residue concentration versus time post-application. By using a first order linear decay model, the half-life can be estimated using the following formula: $t_{1/2} = \ln(1/2)/\text{slope}e$.

**RESULTS**
The results of the sample analysis can be found in Table 1 along with the estimated initial deposition and the calculated half-life. The calculated half-life ranged from 2.5 to 4.0 days ($r = 0.73-0.96$) for the four houses sampled, and was 2.8 days ($r = 0.92$) for the combined data. The half-life of 4.0 days ($r = 0.73$) was calculated for the northeast house. The correlation ($r$) for the regressions from the northwest, southwest and southeast houses are significant ($p>0.05$); but not that of the northeast house. Due to extensive plant damage, the plants in this house were removed from the house prior to our collection of the 7-day post-application sample; thus samples were collected at only 3 intervals. The extensive plant damage, (extensive brown, dead spots) may affect the way in which methomyl dissipates from the plant. Due to the plant damage and the short sampling period, the half-life for this house may be artificially high.

Initial deposition for the four houses ranged from 0.044 to 0.087 ug/cm² (0.067 ug/cm² for the four houses combined). The regression lines are presented in Figure 1 (the line for the northeast house is not included).

**DISCUSSION AND CONCLUSIONS**
Reeve et al. (1990) found average half-life estimates for methomyl on grape foliage that ranged from 2.1 days in June to 4.4 days in October. The half-life values calculated for this data set on cucumber foliage are within the range of those found by Reeve et al. and most closely approximate those found from applications made in August (average of 3.52 days). In a compilation of pesticide persistence studies, Willis and McDowell (1987) report methomyl half-lives in the range of 0.4-8.5 days from studies on cotton foliage and 0.8 days from studies on mint foliage.

The estimated initial deposition appears to be approximately an order of magnitude lower for the greenhouse environment than those estimated from the work of Reeve et al. and are more in the range of the residues that would be expected approximately 7 to 12 days post-application (August applications). This may be due to the generally lower application rates (0.9 vs. 0.45 lb. ai/acre) and the much lower dilution rates (50-200 vs. 2 gallons) for grape versus greenhouse applications. Application techniques (high volume vs. ultra low volume fogger) probably play a role in this difference also. These application differences may not fully explain the differences in the initial deposition; mass balance sampling would be necessary and is outside the scope of this work.
The cucumbers are picked on a daily basis from actively producing plants. Workers involved in the harvest operations begin work each morning by picking cucumbers; this activity lasts about 4 hours each day. During harvest, the workers walk down the aisle, constantly in contact with foliage, and reach into the plant canopy to pick ripe cucumbers. Thus there is the potential for considerable exposure to pesticide residue. The second half of the day is spent processing the cucumbers for market.

Due to the relatively high temperature and humidity in the greenhouses, some workers wear shorts or knee-length pants and short sleeves during normal harvest activities (most workers covered their arms due to the irritating nature of the plants). Foliar contact with the legs is minimal as most of the foliage covering the aisles is above the waist level.

The calculated methomyl residue at 48 hours ranged from 0.028 to 0.061 ug/cm². The highest 48-hour residue was calculated for the northeast house and may be high due to the extreme necrosis of the cucumber leaves throughout the house. (The next highest 48-hour residue was calculated to be 0.046 ug/cm².) Observation of work tasks suggests that worker foliar contact with the greenhouse-grown cucumbers would probably be the same or less than that described by O'Malley et al. (1991) that led to the worker illnesses. Using O'Malley's calculated safe work level for workers girdling grapes (0.1 ug/cm²), it would appear that workers entering a greenhouse, under the conditions studied, could harvest cucumbers at 48 hours post-application with minimal exposure. Protective clothing after the expiration of the reentry interval, would not appear to be necessary under the conditions studied.

REFERENCES


### Table 1:

**METHOMYL RESIDUES ON GREENHOUSE-GROWN CUCUMBER FOLIAGE**

<table>
<thead>
<tr>
<th>House</th>
<th>Plants</th>
<th>Sample Interval (days)</th>
<th>Methomyl Residues (ug/cm²)</th>
<th>Mean (ug/cm²)</th>
<th>Standard Deviation</th>
<th>Estimated Half-life (days)</th>
<th>Est. Initial Deposition (ug/cm²)</th>
<th>R-squared</th>
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Figure 1:

DISSIPATION OF METHOMYL RESIDUES
ON GREENHOUSE-GROWN CUCUMBER FOLIAGE

- Northwest: $Y = -0.22X - 3.12$, $R^2 = 0.85$
- Southwest: $Y = -0.27X - 2.53$, $R^2 = 0.92$
- Southeast: $Y = -0.22X - 2.91$, $R^2 = 0.82$

Days Post-Application

$\ln(DFR) \text{ (ug/cm}^2\text{)}$

[Graph showing data points and regression lines for Northwest, Southwest, and Southeast]