California Department of Food and Agriculture
Environmental Monitoring and Pest Management
1220 N Street, Room A-149
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# MONITORING INADVERTENT PESTICIDE RESIDUES ON MINOR CROPS IN STANISLAUS COUNTY

## I. INTRODUCTION

The Environmental Hazards Assessment Program (EHAP) of the California Department of Food and Agriculture (CDFA) was asked by Pesticide Use Enforcement (PUE) to investigate the source of inadvertent pesticide residues found on vegetables in Stanislaus County. During the winters of 1986 and 1988, four organophosphate (OP) pesticides were found on row crops during routine PUE testing of commercial produce. The row crops consisted of a variety of leafy produce grown on three ranches immediately surrounded by walnut, almond and peach orchards. The four pesticides were parathion, diazinon, chlorpyrifos, and methidathion which were used locally as dormant spray ingredients during the months of December and January.

The most likely source of pesticide residues found in the commercial produce areas was orchard spraying. However, this does not necessarily imply improper application by growers. Glotfelty et al. (1987) have shown that fog water may contain enriched concentrations of dissolved pesticide as compared to air concentrations. Fog moving through an orchard and passing over a field where row crops are grown may carry pesticides in solution within fog droplets from the orchard to the field. Another possible source of inadvertent residues may be dry deposition from wind-borne particulates. In light of the potential problems these residues may cause for orchard growers and vegetable crop growers alike, EHAP will attempt to answer the following questions:

1. Are residues found on vegetable crops being transported from local orchards (within 1/4 mile of field) or from orchards farther away? In other words, is this a local or regional problem?

2. Is fog liquid responsible for the transport of pesticides from orchards into fields? Is there any relationship between the number of fog events and the quantity of residue found on crops?

3. Is particulate pesticide carried from orchards by wind and dry deposited on row crops during non-fog periods?

## II. OBJECTIVES

EHAP will attempt to assess fog liquid as a potential means of transport of pesticide from orchards into fields. In addition, wind-borne particulates will be investigated as a source. A qualitative assessment will be made of the role fog and wind play in transporting pesticides locally and regionally.

## III. PERSONNEL

This project will be under the overall supervision of John Sanders. Additional support will be provided by:

Bonnie Turner, Project Leader
Sally Powell, Experimental Design/Statistician
David Gonzalez, Field Group Coordinator
Nancy Miller, Chemistry Lab Liaison
Jane Melvin, Chemist
Mark Pepple, Public and Agency Liaison, (916)322-2395

## IV. STUDY DESIGN

The dormant spray season normally lasts from December 1 until January 31. Pesticide Use Report summaries from 1985 and 1986 plus available 1988 data gathered by PUE indicate that most parathion used as dormant spray is applied in January. Therefore our study will take place in January 1989.

All four OP pesticides will be monitored in this study, but special emphasis will be given to parathion. Parathion is the most heavily used of the four dormant spray ingredients, and was detected in 1986 and 1988 PUE samples.

Three study sites in Stanislaus County will be used. Each site will be a field approximately 150 acres in area (the size of a representative row crop field) on which row crops or other low-growing vegetation is planted, and which is immediately surrounded by orchards where one or more of the four OP pesticides are normally applied in dormant spray. Around two sites, buffer areas 1/4-mile wide (approximately 480 acres for each buffer area) will be created within which the use of parathion will be prohibited during December and January. Application of the other three OPs will be permitted as usual, and they may be substituted for parathion at the grower's discretion. One of these sites will be a field that was the source of crops on which inadvertent residues were detected by PUE. The second field will be one on which no residues were detected. These two sites will be referred to as the "experimental" sites. Around the third site, dormant spraying in the orchards will proceed as usual, including the application of parathion as well as the other three OPs. The field will be one where no residues were found by PUE. This site will be called the "control" site.

**Pesticide content of fog** - To investigate whether fog can transport pesticides more than 1/4 mile, fog samples will be taken during each of at least 10 separate fog events at each site. One-way analysis of variance (ANOVA) will be used to compare the pesticide contents of fog for the three sites. If no parathion is detected at the experimental sites, it will indicate that fog does not carry the compound over 1/4 mile. This conclusion would be strengthened if it were also observed that the three non-prohibited OPs did occur in the fog at the experimental sites, since this would rule out as a competing explanation failure of the sampling or analytic methods to detect compounds in fog. If all three sites have parathion in fog in amounts that do not differ significantly (and if the statistical power of the test is sufficient), it will indicate that regional transport only, and not local application, contributes to the parathion content of the fog. If all three sites have parathion in fog but the control site has a significantly higher parathion concentration, it will suggest that both regional transport and local application contribute.

**Pesticide deposition by fog** - The fog analysis will indicate whether fog is carrying the pesticides and whether it is from a long or short distance. However, if there is long-range transport, it would be important to know whether the fog can actually deposit residues on crops. To investigate this question, kimbie fallout cards will be placed in each site during each of the 10 (or more) fog events to sample pesticide deposition. The three sites will be compared using one-way ANOVA. If fog is depositing pesticide, then there should be pesticide detected on the fallout cards. Moreover, there should be the same relationship among the average deposited concentrations for the three sites as among the average concentrations in fog for the three sites. For example, if the control site has a significantly higher average concentration of parathion in fog than the two experimental sites, and the experimental sites do not differ from each other, then the same relationship would be expected among the average amounts of deposition for the three sites. (It must be noted that this sampling will only look at deposition during single fog events. It is possible that no single fog event will result in detectable deposition, but that the cumulative deposition by consecutive events would be detectable. Cumulative deposition will be examined in the vegetation sampling described below.)

**Pesticide deposition by dry air** - Another possible mode of regional transport is dry deposition (deposition during dry-air periods) of wind-borne particulates. To investigate whether this occurs, kimbie fallout cards will be placed in each site during each of at least 10 non-fog days. The three sites will be compared using one-way ANOVA. The amount of pesticide deposited per unit area will be estimated, and we will attempt to relate the amounts of residue detected on vegetation to the amounts deposited by fog and dry deposition.

**Accumulation of residues in vegetation** - At each site, a vegetation sample placed in the field by EHAP at the beginning of the study will be collected every third day. For each site, a graph will be made plotting the concentration of each of the four pesticides in vegetation over days. The same plot will show the occurences of fog and the days on which each of the pesticides was applied in the buffer area (to the extent that this can be determined).

Site results will be compared graphically to see whether they suggest an accumulation of pesticide in vegetation over time, and whether it could be due to deposition from fog which has carried the material over short or long distances. Increases in a concentration level following a local application would suggest local drift, while increases following fog events would suggest deposition by fog. Increases in the level of parathion following fog events in the experimental sites would suggest long-range fog transport, while increases following fog events in the control site would suggest short-range and/or long-range fog transport. No comprehensive statistical analysis of these data will be possible. Instead, a careful subjective interpretation will be made.

## V. SAMPLING METHODS

**Vegetation** - At each of the three sites, ten flats of vegetation containing 20 plants each will be positioned at regular intervals throughout the site. (Dill weed may be used as the vegetation since it appears to pick up the OP compounds very readily.) Every three days during the study period one composite sample will be collected at each site. Each composite will consist of ten plants, one plant collected from each of the ten flats. The vegetation will be clipped at the roots and placed into containers and frozen until analysis.

**Fog** - Fog samples will be collected using samplers based upon a design by B. Daube, Jr. et al. (1987), California Institute of Technology. Teflon monofilament is used to intercept liquid fog as the droplets are drawn through a narrow tunnel by a motorized fan at a rate of 25 $m^3$/min. As the droplets strike the filaments, they are drawn down into a collection bottle. Samplers will be placed in each field and operated for standardized intervals during fog events throughout the study period. Fog water samples will be collected and stored in amber 1-liter bottles and refrigerated until analysis.

**Dry Deposition** - Dry deposition of particulate pesticides will be measured by placing kimbie fallout cards in each field during non-fog daylight hours (minimum of four hours). Ten cards per field will be used for each event and composited into one sample (at each site). A maximum of

10 days will be sampled throughout the study period. Cards will be stored frozen until analysis.

**Wet Deposition** - Wet deposition of particulate pesticides by fog will be measured by placing kimbie fallout cards in each field during fog events whenever fogwater is sampled (10 events). Ten cards per field will be used for each event and composited into one sample. Cards will be stored frozen until analysis.

## VI. CHEMISTRY METHODS

The CDFA laboratory will be responsible for developing methods to screen for the four organophosphate pesticides of interest (parathion, diazinon, chlorpyrifos and methidathion) in fog water, vegetation and fallout cards. Samples will be analyzed by gas chromatography.

## VII. TIMETABLE

Dormant spraying in orchards usually begins December 1 and continues until January 30. Background fog, vegetable and fallout card samples will be collected prior to December if possible. Study samples will be collected throughout January. Chemical analysis should be completed by April 30, and a report should be ready for peer review by July 1.

## VIII. REFERENCES

Daube, B.C., Jr., R.C. Flagan, and M.R. Hoffmann, Active Cloudwater Collector. United States Patent No. 4,697,462, dated October 6, 1987.

Glotfelty, D.E., J.N. Seiber, and L.A. Liljedahl. "Pesticides in fog," Nature, February 1987.

## IX. BUDGET

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| Personnel Costs: | $10,000 |
| Operating Expenses: | 35,000 |
| Total: | $45,000 |